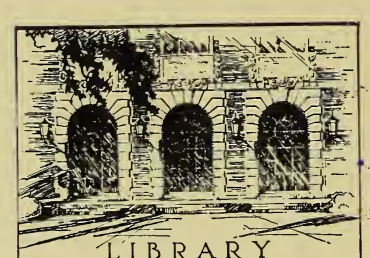

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Graduate College

1954-1956

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1953-1954

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Morell Belote Russell, Ph.D., Professor of Agronomy and Head of the Department of Agronomy

Francis Graham Wilson, Ph.D., Professor of Political Science and Chairman of the Department of Political Science

Calendar

1954 — FIRST SEMESTER

Sept. 15, Wed.-Sept. 18, Sat.	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by September 1.)
September 18, Saturday	Latest date for registration of former students without payment of late registration fee.
September 20, Monday	Instruction begins.
October 1, Friday	Latest date to apply for French examination on October 15.
October 8, Friday	Latest date to apply for German examination on October 22.
October 11, Monday	Latest date for changing program without fee.
October 15, Friday evening	French examination.
October 22, Friday evening	German examination.
October 30, Saturday noon	Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to the "third" year.
November 1, Monday	Latest date for adding a course to program.
November 1, Monday	Latest date for candidates for professional engineering degrees to file statements of professional study and experience.
November 19, Friday	Latest date to apply for French or German examination on December 3.
November 24, Wednesday, 1 p.m.	Thanksgiving vacation begins.
November 29, Monday, 1 p.m.	Thanksgiving vacation ends.
December 3, Friday	Illinois Day (State admitted to the Union, 1818).
December 3, Friday evening	French examination and German examination.
December 13, Monday	Latest date for dropping a course without penalty (grade of E).
December 18, Saturday noon	Christmas vacation begins.
December 31, Friday	Latest date for candidates for professional engineering degrees to submit outlines of theses.

1955

January 3, Monday, 1 p.m.	Christmas vacation ends.
January 14, Friday	Latest date for candidates for Ph.D. degree in February to submit theses to Graduate College for approval of format.
Jan. 21, Fri.-Jan. 29, Sat.	Semester examinations.
January 21, Friday	No names will be added to the February graduation list after this date.
January 21, Friday	Latest date for candidates for the master's degree in February to deposit theses.

January 29, Saturday noon	Latest date for finals for Ph.D. degree in February.
February 2, Wednesday	Latest date for candidates for Ph.D. degree in February to deposit theses and abstracts.

1955 — SECOND SEMESTER

Feb. 7, Mon.-Feb. 9, Wed.	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by January 15.)
February 9, Wednesday	Latest date for registration of former students without payment of late registration fee.
February 10, Thursday	Instruction begins.
February 15, Tuesday	Latest date for applications for fellowships for 1955-1956.
February 18, Friday	Latest date to apply for French examination on March 4.
February 25, Friday	Latest date to apply for German examination on March 11.
March 2, Wednesday	University Day (University opened, 1868).
March 4, Friday evening	French examination.
March 7, Monday	Latest date for changing program without fee.
March 11, Friday evening	German examination.
March 19, Saturday	Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to the "third" year.
March 21, Monday	Latest date for adding a course to program.
April 7, Thursday, 1 p.m.	Easter vacation begins.
April 13, Wednesday, 1 p.m.	Easter vacation ends.
April 15, Friday	Latest date to apply for French examination on April 29.
April 22, Friday	Latest date to apply for German examination on May 6.
April 25, Monday	Latest date for dropping a course without penalty (grade of E).
April 29, Friday	Honors Day. Classes dismissed at noon.
April 29, Friday evening	French examination.
May 2, Monday	Latest date for candidates for professional engineering degrees to deposit theses.
May 6, Friday evening	German examination.
May 20, Friday	Latest date for candidates for Ph.D. degree in June to submit theses to Graduate College for approval of format.
May 27, Friday	No names will be added to the June graduation list after this date.
May 27, Friday	Latest date for candidates for the master's degree in June to deposit theses.
May 30, Monday	Memorial Day. No classes.
June 2, Thurs.-June 10, Fri.	Semester examinations.
June 4, Saturday noon	Latest date for finals for Ph.D. degree in June.

June 8, Wednesday.....Latest date for candidates for Ph.D. degree in June to deposit theses and abstracts.
June 19, Sunday.....Commencement exercises.

1955 — SUMMER SESSION

June 17, Fri.-June 18, Sat.....Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 17.)
June 20, Monday.....Instruction begins.
July 4, Monday.....Independence Day. No classes.
July 5, Tuesday.....Latest date to apply for French examination on July 15.
July 5, Tuesday.....Latest date for changing program without fee.
July 8, Friday.....Latest date to apply for German examination on July 22.
July 15, Friday evening.....French examination.
July 22, Friday evening.....German examination.
July 25, Monday.....Latest date for dropping a course without penalty (grade of E).
Aug. 12, Fri.-Aug. 13, Sat.....Summer session examinations.
August 12, Friday.....No names will be added to the August graduation list after this date.
August 12, Friday.....Latest date for candidates for the master's degree in August to deposit theses.
September 16, Friday.....Latest date for candidates for Ph.D. degree in October to submit theses to Graduate College for approval of format.
September 30, Friday.....Latest date to file application for the master's degree in October.
September 30, Friday.....Latest date for candidates for the master's degree in October to deposit theses.
September 30, Friday.....Latest date for finals for Ph.D. degree in October.
October 7, Friday.....Latest date for candidates for Ph.D. degree in October to deposit theses and abstracts.

NOTES FOR CANDIDATES FOR THE DOCTORATE

The two required language examinations should be passed as early as possible and must be passed in the term preceding the preliminary examination or at least two months prior to that examination.

The general thesis subject is made known to the doctoral committee at the time of the preliminary examination. The final thesis topic should be submitted to the Graduate College about three months prior to the conferring of the degree.

The thesis must be submitted to the Graduate College for approval of the format at least two weeks prior to the date of the final examination. See pamphlet "Instructions on the Preparation of Theses," which can be obtained in Room 109 Administration Building (East).

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*Aeronautical Engineering	Henry Sheldon Stillwell
Agricultural Economics	Harold Clayton M. Case
*Agricultural Engineering	Emil Wilhelm Lehmann
Agronomy	Morell Belote Russell
Animal Nutrition	Thomas Sherman Hamilton
Animal Science	Leslie Ellsworth Card
*Architecture	Alan Kemp Laing
*Art	Cecil Vincent Donovan
*Astronomy	George Cunliffe McVittie
Bacteriology	Halvor Orin Halvorson
*Biological Sciences	Frank Bolton Adamstone
Botany	Oswald Tippo
Business	Paul Dulaney Converse
Ceramic Engineering	Andrew Irving Andrews
Chemical Engineering	H. Fraser Johnstone
Chemistry	Herbert Edmund Carter
*City Planning	Karl B. Lohmann
Civil Engineering	Whitney Clark Huntington
Classics	John Lewis Heller
*Commercial Teaching	Arnold Clarion Condon
Dairy Science	Glenn Wade Salisbury
Dairy Technology	Paul Hubert Tracy
Economics	Harry Kenneth Allen
Education	B. L. Dodds
Electrical Engineering	Edward Conrad Jordan
English	Gordon Norton Ray
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Food Technology	Reid Thompson Milner
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Geology	George Willard White

* Give work for master's degrees only.

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*Journalism	Fredrick Seaton Siebert
*Labor and Industrial Relations	Robben Wright Fleming
*Landscape Architecture	Karl B. Lohmann
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Library Science	Robert Bingham Downs
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Marketing	Paul Dulaney Converse
Mass Communications	Fredrick Seaton Siebert
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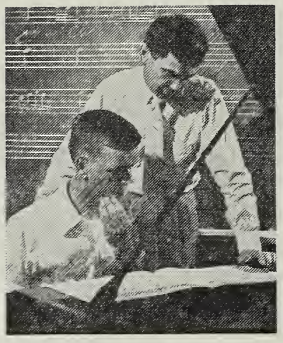
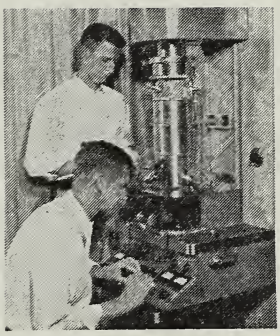
Mechanical Engineering	Norman Alwyn Parker
Mining and Metallurgical Engineering	Thomas Albert Read
Music	Duane Adams Branigan
Philosophy	Dilman Walter Gotshalk
Physical Education	Seward Charle Staley
*Physical Sciences	John Christian Bailar, Jr.
Physico-Chemical Biology	Robert Emerson
Physics	F. Wheeler Loomis
Physiology	Robert Eugene Johnson
Plant Pathology	Wayne Melville Bever
Political Science	Francis Graham Wilson
Psychology	Lyle Hicks Lanier
*Social Sciences	Royden Dangerfield
*Social Work	Marietta Stevenson
Sociology and Anthropology	James Edward Hulett, Jr.
Spanish and Italian	John Van Horne
Speech	Karl Richards Wallace
Statistics	William Gregory Madow
Theoretical and Applied Mechanics	Thomas James Dolan
Veterinary Pathology and Hygiene	Joseph Ortan Alberts
Zoology	Frank Bolton Adamstone

* Give work for master's degrees only.





The Graduate College

The University of Illinois offers graduate instruction on the Urbana campus and on the campus of the professional colleges in Chicago. This bulletin describes only the programs of study and the courses offered at Urbana. Questions concerning programs in the medical and dental sciences and in pharmacy should be directed to Dr. Milan Novak, Associate Dean of the Graduate College, Chicago Professional Colleges, 808 South Wood Street, Chicago 12, Illinois.

Character of Graduate Work. Formal instruction, though ordinarily necessary to supplement undergraduate preparation, is by no means the most important part of a graduate program. The main purpose of graduate work is to enable a student to broaden his knowledge of a given field and to increase his competence. Graduate work, especially in the second and third year of a doctoral program, aims at the development of independent scholarship, originality, and competence in research. Achievement of these aims is usually sought through instruction in small classes or seminars, according to methods, standards, and ideals which vary widely from one field to another.

Admission

Application blanks for admission can be obtained from the Director of Admissions and Records or from the Graduate College. They should be prepared in duplicate and returned to the Director of Admissions. Official transcripts from all other colleges attended must be sent directly to the Office of Admissions and Records by the colleges concerned. In order to avoid delay during the registration period, applications for admission should be submitted at least three weeks prior to the day instruction begins. An application will be accepted at a later date, but there may be delay in processing it.

Subject to the specific regulations described below, admission will be granted to applicants who have a bachelor's degree corresponding to that granted by this University, providing the undergraduate preparation is adequate for advanced study in the major and minor fields.

Candidates for the Master's Degree. Admission with full standing is granted to applicants whose grade-point average for the last fifty per cent of the hours completed for the bachelor's degree is at least 3.5 (A = 5.0). Required physical education and military training are not

included in this computation. Certain departments require of entering graduate students a minimum grade-point average higher than 3.5. Information concerning the average required for admission to each field of study will be found in the departmental sections. As of September, 1954, applicants whose grade-point average is below 3.5 are admitted with limited status for study in the areas of Agricultural Economics, Architecture and Architectural Engineering, Dairy Science, French, History, Home Economics, Landscape Architecture, Mathematics, Mining and Metallurgical Engineering, Social Work, Sociology and Anthropology, Speech, Statistics, and Veterinary Pathology and Hygiene. Students admitted on limited status may petition for full standing after completing at least three units of satisfactory work.

Candidates for the Doctor's Degree. Upon the recommendation of the head of the department of the major field of study and with the approval of the Dean of the Graduate College, admission with advanced standing is granted to applicants who have completed a master's degree or the equivalent elsewhere and who desire to become candidates for the doctor's degree at the University of Illinois. If the applicant is admitted, his year of advanced study completed elsewhere will be accepted as one year of residence, but the amount of credit to be accumulated at the University of Illinois before the candidate can be admitted to the preliminary examination can be determined only by the advisers in the major and minor fields after the student has registered and completed some work here.

Graduate Study by College Seniors. A college senior who has been in residence for at least two semesters and who is within five semester hours of his bachelor's degree may be admitted to the Graduate College if his grade-point average for the last fifty per cent of the hours completed is approximately 4.0. Seniors who meet these requirements and who wish to apply should submit an application for admission to the Director of Admissions together with a letter from the dean of the undergraduate college specifying the hours needed to secure the bachelor's degree. If admitted to the Graduate College, the student carries as miscellaneous course work the hours needed to complete the requirements for the first degree; in addition, he registers for courses to be credited toward an advanced degree.

A senior who is within ten hours of the bachelor's degree may register in graduate courses for graduate credit if his grade-point average is that specified above and if he secures the approval of the head of the major department and the instructors concerned. In all such cases, the program card must be signed by the Dean of the Graduate

College before registration is completed. Graduate credit so earned will not count toward an advanced degree unless the student qualifies for admission with full standing at the close of the session and enrolls as a graduate student during the following regular semester.

Advisers. Every graduate student must have an adviser. The adviser's primary duty is to assist the student in planning and carrying through a program of graduate work which will fit the needs and desires of the student, and at the same time will satisfy departmental and Graduate College requirements. A new graduate student should go to his major department to discuss the selection of an adviser.

Students from Abroad. A student from abroad who wishes to be admitted to graduate study at the University of Illinois should write to the Director of Admissions, 100a Administration Building, Urbana, Illinois, enclosing copies of his academic records certified by the educational institutions previously attended. No application form is submitted until the student arrives on the campus. Students whose native tongue is not English are required to take an examination in English before registration. If command of the language is not adequate, enrollment in courses for the study of English as a foreign language is required.

The Assistant Dean for Foreign Students, Mr. George H. Bargh, 152 Administration Building (West), will assist students from abroad with problems involving passports, visas, and other matters.

Time Limit for Advanced Degrees. From the time of entrance upon graduate study at the University of Illinois, the work for a master's degree must be completed in not more than six calendar years, and that for a doctorate in not more than seven calendar years. If the completion of the requirements is delayed for reasons beyond the control of the student, he may request an extension of time by submitting a petition (see page 18).

Registration and Program of Studies

Registration. Dates for registration in the Graduate College are shown in the calendar (page 7). A former graduate student who registers late must pay a late registration fee of $5.00. The registration of a new student will be accepted at any time, provided he is prepared to enter courses already under way for credit reduced in proportion to the length of time which has elapsed since instruction began. He is not charged the late registration fee.

A graduate student obtains a program card and other registration material, including an instruction sheet, from the Graduate College

office, 105 Administration Building (East), during scheduled registration days or at any time thereafter.

Changes in Program Cards. Because a graduate student is expected to plan his work carefully with his adviser, changes in his program during the semester should not be necessary. However, if, in the judgment of a student and his adviser, a change is required, the student should obtain a change-of-study form at the Graduate College office. This form must be signed by the adviser, the instructors involved, and the Dean of the Graduate College. After the dates indicated in the calendar a fee of $1.00 is charged for each change. Except in cases of illness certified by an attending physician, *a student will not be permitted to drop a course during the last six weeks of a regular session.* The final date for dropping a course is shown in the calendar.

Unit Credit for Courses. Courses numbered from 300 to 399 are open to advanced undergraduate and graduate students, and those numbered 400 and above are open to graduate students only. Courses numbered below 300 do not carry graduate credit.

Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five. The credit which may be earned in individual courses is indicated in the course listing, and is in some instances variable.

Miscellaneous Courses. A graduate student carrying a normal graduate program may elect one miscellaneous subject (a course which does not give credit toward an advanced degree). If it is necessary for a graduate student to carry at the same time more than one miscellaneous subject, he may not register for a full graduate program. Courses intended to teach graduate students a reading knowledge of French or German are regarded as miscellaneous courses.

Auditing Privileges. A graduate student is permitted to attend classes as an auditor, provided a card bearing the approval of his adviser and of the instructor is filed at the Graduate College office. A student should not enter on his program card courses which he will attend as an auditor.

Graduate Programs for Employed Students. A student who is employed can not expect to complete his academic work as promptly as one who devotes full time to his academic program. The academic work carried by assistants and others on the University staff is limited by statute, and no deviation is permitted without compelling reasons. Those employed outside the University are expected to reduce their program

of work in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Nature of Appointment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1 unit
Two-thirds time	2¼ units	1 unit
Half time	3 units	1½ units
One-third time	3½ units	2 units
One-fourth time	4 units	2 units

Extramural Course Work. Graduate courses in a few areas of study are offered at various centers throughout the state. No student may register for more than one unit of extramural course work in any one semester, and no student who is employed full time may register for more than one unit each semester by enrolling for any combination of extramural and campus courses.

Extramural course work is not considered as work in residence. However, credit earned is accepted in partial fulfillment of the requirements for a master's degree providing the courses involved have been selected with the consent of the adviser and constitute part of a well-integrated program of study. Students accumulating credit for a master's degree through extramural course work must also meet the residence requirements for the degree desired (see general residence requirements for A.M. and M.S. on page 19 and for Ed.M. on page 104). Credit earned in extramural courses can not be applied to advanced degrees beyond the master's. No credit toward an advanced degree is allowed for correspondence courses.

Grades. Grades are recorded by the following letters: A, B, C, D, E. Any student who receives two units of grade below B must complete two additional units of A or B grade to qualify for an advanced degree. Three units of a grade below B disqualify a student as a candidate. A grade of E in any course in the major field precludes the conferring of a degree in the academic year in which the failure is incurred.

Withdrawal. When a student drops all the course work in which he currently is enrolled, even if he is enrolled in only one course, he is considered to be withdrawing from the University. A student who wishes to withdraw from the University should obtain a withdrawal slip from the Graduate College office. A student who leaves the University without completing the steps necessary for withdrawal will receive failing grades in all course work. If a student withdraws from the Uni-

versity and wishes to register again, he must fill in an application for readmission. These forms are available at the offices of the Graduate College and the Director of Admissions.

Graduate Study in the Summer. Credit earned during summer sessions may be applied to advanced degrees, subject to the residence requirement for the degree desired. The normal program for a summer term is two units; two and one-half units may be carried with the approval of the adviser. In no case will a student be permitted to carry more than two and one-half units.

Petitions. The normal procedures and requirements of the Graduate College are indicated in this catalog, but these may be modified occasionally for justifiable reasons. A student may petition the Dean and the Executive Faculty of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms can be secured at the Graduate College office.

Conferring of Degrees. Advanced degrees are conferred in February, June, August, and October, except the doctor's, which is not awarded in August. Each student is responsible for entering on his registration cards at the proper time the fact that he is a candidate for a degree to be awarded at the end of the current term. If the candidate is not currently registered in the Graduate College, he must present his application to receive a degree at the Graduate College office no later than the final date specified in the calendar.

Each candidate for an advanced degree must obtain a clearance paper from the Graduate College after he has completed all of his work. The student must obtain all the signatures called for on the form and return it to the Graduate College.

The Master's Degree

Requirements. A candidate for the master's degree must satisfy residence requirements and must complete at least eight units with satisfactory grades. It is expected that three of the eight units will be in courses numbered in the 400 series, and two of these must be in the major field. The teacher-training curricula and certain special programs are exempt from this regulation. Some departments require a thesis; others do not. A few require nine units of course work if the thesis requirement is waived. The candidate must satisfy the specific departmental requirements in addition to the general requirements of the Graduate College. Departmental requirements are stated in the catalog under the major areas of study.

Residence Requirements. A candidate for the master's degree (except the Ed.M.) is required to be in residence for the equivalent of at least two semesters. A student is in residence only when registered in the Graduate College and spending full time on the Urbana campus. Such a student earns one semester of residence if he is registered for two units. Students in residence who are carrying lighter programs of work must spend a proportionately longer time in satisfying this requirement; thus, for example, a full-time assistant registered for one unit each semester would discharge the residence requirement in four semesters of work.

Attendance during four summer sessions in each of which the student is registered for not less than one unit of work, or in one semester with not less than two units and two summer sessions with not less than one unit each, is regarded as the equivalent of two semesters in residence. Registration for more than two units in a regular semester, or for more than one unit in a summer session, will not shorten the time which must be spent to discharge the residence requirement.

Work Done Elsewhere. A graduate student who has done graduate work in other approved institutions may petition to obtain credit not to exceed four units toward the master's degree by passing examinations in that work. Admission to such examinations requires the prior approval of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement of two semesters.

If it is recommended in advance by the adviser, the Graduate College may permit a student to register for work at a laboratory elsewhere offering facilities not available at Urbana, or in approved field work, with the understanding that such work will be accepted for graduate credit if completed satisfactorily. The adviser will examine the student's transcript and will examine the student directly when he returns to this campus and will then make a final recommendation to the Dean of the Graduate College concerning the credit to be given.

Majors and Minors. A candidate for a master's degree may do all his work in one field, or he may select a major and one minor, or a major and two minors, as indicated in specific cases in the latter part of this catalog. A major or minor denotes the field of knowledge of a department, or such part thereof as constitutes a separate and independent division of that field. The adviser will determine what courses in the major field are suited to the candidate's special objective, but the head of the minor department must approve the courses selected for the minor area of study. For a master's degree a major comprises work

totaling a minimum of four units. Less than one unit of work will not satisfy the requirements for a minor.

Foreign Language. The ability to use one or more of the modern languages ordinarily studied in the undergraduate curriculum is desired for all candidates for the master's degree and is required in some lines of study. A student who plans to become a candidate for the Doctor of Philosophy degree should take at least one of the Graduate College language examinations during the first year of graduate study.

Master's Thesis. The subject of a thesis for the master's degree must be filed at the Graduate College office *by the student during the registration period prior to his graduation.* A student usually devotes two units of work to his thesis, and no more than three units of thesis credit may be included in an eight-unit program except by special permission. For specific instructions with reference to the preparation and form of the thesis, the student should obtain at the Graduate College office a copy of the leaflet "Instructions for Preparation of Theses." Two copies of the thesis with Certificates of Approval must be presented to the Graduate College office by the date specified in the calendar of the Graduate College. Candidates are expected to have at least four copies of the thesis. The original and first carbon must be deposited in the Graduate College; the other two are for the major department and the author. The Certificate of Approval for the master's thesis must be signed by the person under whose immediate supervision the thesis was prepared and also by the head of the major department. Blank certificate forms can be obtained at the Graduate College office.

The requirement of a thesis may be waived, on the recommendation of the department and with the approval of the Dean, *provided application to waive the thesis is made at the time for announcing thesis subjects.* A student excused from writing a thesis must replace it with courses of instruction.

Thesis Work on Leave of Absence. A student who has completed six units of course work in residence and who wishes to complete the thesis in absentia should consult first with his adviser. If the request meets with the latter's approval, a petition is submitted. The petition must include an outline of the proposed investigation and evidence that adequate facilities for pursuing it will be available. If the work is to be done in an industrial laboratory, it will be necessary to secure a letter from the company releasing to the University all patent and publication rights.

Teacher-Education Programs. Programs leading to the master's degree for teachers in various fields are offered to students who have

satisfactorily completed the four-year undergraduate teacher-training program. Students who have not met all of the requirements of a four-year undergraduate curriculum but wish to take the fifth year of work for a master's degree may register in an approved program with the permission of the adviser and the Coordinator of Teacher Education. Two units of the required work in education may be completed in extramural graduate courses. Programs for teachers are offered in the following areas, the special requirements for each being given in this catalog at the page indicated:

Agriculture—page 43
Art—page 54
Biological Sciences and General Science—page 59
Chemistry—page 71
Commercial Teaching—page 66
Education of the Deaf—page 103
Education of Mentally Handicapped Children—page 103
English—page 126
French—page 138
Geography—page 143
German—page 151
Health Education—page 218
Home Economics—page 159
Industrial Education—page 102
Latin—page 90
Mathematics—page 188
Mathematics and the Physical Sciences—page 188
Music—page 203
Physical Education—page 216
Physical Sciences—page 221
Physics—page 223
Social Studies—page 246
Spanish—page 258
Speech—page 262
Speech Correction—page 262

The Degree of Doctor of Philosophy

The degree of Doctor of Philosophy is offered in the fields indicated on page 10. The general requirements for the degree are described below. Special departmental requirements will be found under the departmental listings. For information concerning the degree of Doctor of Education, see Education and Music.

Residence Requirements. For the degree of Doctor of Philosophy, the student must spend three "years" in resident study at an accredited educational institution; such "years" are defined as follows:

First "Year." The time required to complete eight units of graduate work with satisfactory grades.

Second "Year." The time required to progress from the completion of the first year's work through the completion of the preliminary examination. This involves obtaining satisfactory grades in eight more units of graduate work, completion of the foreign language requirement, and passing the preliminary examination.

Third "Year." The time spent between passing the preliminary examination and the completion of all requirements for the doctor's degree,

including eight units of research, writing a satisfactory thesis, and passing the final examination.

A student who spends the first two years in residence at the University of Illinois may petition to spend the last year in absentia. A student who has completed the first year of graduate work elsewhere must be in residence during the two remaining years. In exceptional cases, a student with two years of graduate study elsewhere who satisfies his major department that he has completed work equivalent to the standard departmental requirements will be permitted to take his preliminary examination, provided he has fulfilled the language requirements. If such a student passes the preliminary examination, he may complete the requirements for the Doctor of Philosophy degree by devoting the third year to research in residence.

A student may satisfy the residence requirement in part by attending summer sessions at the University of Illinois. Attendance during four summer sessions is considered the equivalent of one year's residence. However, at some time during the second or third years of his doctoral program, the student must be in residence at the University through two successive semesters.

Major and Minor Subjects. A candidate for the degree of Doctor of Philosophy is required to pursue a major subject in the area of his research interest. He also is required to choose one or two minor subjects. The requirements for a minor in any field should be checked with the department concerned no later than the beginning of the second year, and earlier if possible. If only one minor is chosen, it is called a "sole minor," and must be taken in an area other than that of the major. Credit for it must be earned by work representing not less than four units. If two minors are chosen, the first may be a subject closely related to the major. With the approval of the adviser, it may be a division of the major field of study; it must involve at least two units. In such a case, the second minor (not less than two units) must be taken in an area other than that of the major.

Language Requirements. The student will be required to demonstrate his ability to read two of the following languages: French, German, or Russian. He should take his language examinations as early as possible and must pass both not later than two months prior to the preliminary examination, or during the semester (or summer session) preceding that in which he is admitted to the preliminary examination. The dates of the language examinations and the latest dates when application for admission to these examinations may be made are shown in the calendar (page 7). Certification of proficiency in foreign languages

will not be accepted from other colleges or universities. The examinations must be taken at the University of Illinois.

Doctoral Committee. A permanent doctoral committee for each student will be appointed by the Dean of the Graduate College upon recommendation of the executive officer of the department in which the student is doing his major work. The committee will conduct the preliminary and the final examinations.

Preliminary Examination. A candidate for the doctor's degree must pass a preliminary examination intended to test his knowledge of his major and minor fields of study. He will not be admitted to the examination before (1) he has passed the two required language examinations, (2) he has satisfactorily completed at least sixteen units of graduate work, and (3) his adviser and the head of the department of his minor field of study consider that he has adequate preparation in his major and minor fields. This examination, conducted by the candidate's doctoral committee, will be partly or entirely oral. Consult the calendar of the Graduate College (page 7) for the latest dates for preliminary examinations.

Final Examination. When the thesis has been completed, if the major adviser so recommends, the candidate will be given his final examination by his doctoral committee. A student in the third year of study who fails to meet the expectations of the professors in charge of his work, or in any way fails to maintain the standard of scholarship and power of research expected of him, may be refused admission to the final examination.

Consult the calendar of the Graduate College (page 7) for the latest date for the final examination. This examination is concerned primarily with the research work of the student as embodied in his thesis, but it may be much broader and extend over the whole field of study of the candidate. The intention of the final examination is to determine that the candidate has a satisfactory grasp of his major subject as a whole and a general acquaintance with the fields of knowledge represented by his course of study.

The final examination is oral and will be conducted entirely in the presence of the doctoral committee.

Thesis. The Doctor of Philosophy is primarily a research degree; consequently, the candidate is required to demonstrate his capacity for independent research by the production of an original thesis on some topic connected with his major field of study. The subject of the thesis should be chosen by the end of the second year and must be reported to the doctoral committee and the Graduate College at the time of the

preliminary examination. The student should be registered in his thesis course for the number of units corresponding to the amount of time devoted to thesis research, four units being the equivalent of full-time work.

Not later than two weeks before the time set for his final examination, and not later than four weeks before the time when he hopes to receive the degree, the candidate must submit to the Graduate College, for approval of the format, two typewritten copies of his thesis in final form. The style and form of the thesis must comply with the regulations given in the leaflet "Instructions for Preparation of Theses," copies of which can be obtained in the Graduate College office. It is expected that each candidate will have at least four copies of the thesis. The original and first carbon must be deposited in the Graduate College; the other two are for the major department and the author. After the thesis has been checked at the Graduate College office, the student must arrange for each member of the doctoral committee to read the thesis before the date of the final examination.

Formal publication of the thesis, either in its entirety or in a condensed form, is not required. However, students should consider the advantages to them, and to their professional field, of publication of the significant methods and findings of their research in the technical literature. If published, the article or book should have a note indicating that the material is, or is based upon, a dissertation submitted in partial fulfillment of the requirements for the Ph.D. (or other) degree at the University of Illinois.

In order to insure that theses will be available for use by others it is required that they be microfilmed. Each candidate who passes the final examination must pay a fee of $25.00 and deposit a typewritten abstract of his thesis of approximately six hundred words, together with the original and first carbon of the complete thesis. This fee will provide for (1) microfilming of the complete dissertation, with one copy deposited in the University of Illinois Library, (2) publication of an abstract of six hundred words or less in *Dissertation Abstracts.*

Professional Degrees in Engineering

The University of Illinois offers special programs of graduate study leading to the following professional degrees in engineering: Agricultural Engineer, Master of Architecture, Architectural Engineer, Ceramic Engineer, Chemical Engineer, Civil Engineer, Electrical Engineer, Engineer-Physicist, Mechanical Engineer, Metallurgical Engineer, and Engineer of Mines.

Professional degrees in engineering may be conferred on two classes of candidates: (1) those who have received an academic degree in engineering or in architecture from the University of Illinois; (2) those who have received an academic degree in engineering, including chemical engineering, from other institutions of equal standing and who have been members of the teaching or research staff of the College of Engineering or Engineering Experiment Station or the Departments of Chemistry and Chemical Engineering or Architecture of the University of Illinois for at least three years prior to the conferring of the professional degree.

A candidate declares his candidacy by filing with the Dean of the College of Engineering, as chairman of the committee in charge, a detailed statement covering his professional engineering experience. This statement must be made on a standard form supplied by the Dean of the College of Engineering, and must be filed not later than the first Monday in November preceding the Commencement at which the candidate expects to receive the degree. No statement of experience will be considered by the committee which does not show that the candidate has had a minimum of eight years of acceptable engineering experience after receiving the degree of Bachelor of Science, and that he has been in responsible charge of engineering work for at least five years. Responsible charge in engineering teaching may be considered as responsible charge of work. In determining the acceptability of the engineering experience of the candidate, the committee will be guided by the character of his professional work and the degree of responsibility involved, and will take into consideration such evidences of professional ability and growth as may be shown by his investigation of engineering problems, contributions to technical literature, and his membership and activity in engineering societies.

If the professional experience of the candidate is accepted, he must submit for approval, before December 31, an outline of his proposed thesis. The completed thesis, in the form prescribed in the "Instructions for Preparation of Theses," must be submitted to the Dean of the College of Engineering for approval not later than May 1. Major technical reports or plans and specifications for major engineering projects conceived and designed or directed by the candidate may be submitted for approval in lieu of a thesis. The candidate must attend Commencement in order to receive the degree.

A candidate for a professional engineering degree must pay the tuition fee of $25.00 on being notified that his professional experience is accepted as qualifying him to enter as a candidate for the degree. No one will be enrolled as a candidate for the degree at the following Com-

mencement who does not pay his fee at this time. When a candidate for a professional engineering degree has once been accepted and paid his fee, he is eligible to receive the degree at any time within five years, without additional fee, on completion of the requirements. However, unless he completes the requirements within two years his name will be dropped from the list of candidates and in order to receive the degree within the five-year period he must register again.

Fellowships

Fellowships are awarded each year to promising graduate students for work in any field in which the Graduate College offers an advanced degree. In addition to the stipend, a fellowship award provides exemption from tuition and from the laboratory, library, and supply fee for the academic year in which the fellowship is effective and for the following eight-week summer session. The stipends are $900 for the first year of graduate study, $1,000 for the second year, and $1,100 for the third year. In addition to these regular University fellowships, there are a number of industrial and endowed awards in several areas of study, including chemistry, engineering, agriculture, history, and political science.

An application for a fellowship can be obtained from the office of the Graduate College and must be returned to that office by February 15 to be considered for an award for the following academic year. Applicants in applied music or composition and in applied art are required to submit recordings, original scores, or examples of their art work in addition to the usual transcripts and letters of recommendation. These items should be mailed directly to the head of the major department.

A few special nonresident and postdoctoral fellowships are available each year. The nonresident fellowships are awarded to exceptional graduate students engaged in a research project which requires direct observations or archival work elsewhere. In order to qualify for this award the student must have been in residence for at least one year and must submit a plan which has been approved by the major department. The postdoctoral fellowships are intended to provide opportunities for further training and development to outstanding students of great originality who wish to make use of the research facilities of the University after receiving the doctor's degree. A detailed program of research and study formulated by the applicant must be submitted with the application. Ordinarily, applicants for these special fellowships are interviewed by the Graduate Fellowship Committee.

Fellows are selected by the Graduate Fellowship Committee on the

basis of scholarship and promise in teaching or research as revealed by transcripts, letters of reference, and recommendations by the major departments. Successful applicants will receive a notice of appointment on or about April 1 and are expected to accept or decline by April 15. (See statement of policy adopted by the Association of American Universities under Assistantships below.) At the time an award is accepted at the University of Illinois, the Fellow agrees that without the consent of the Dean of the Graduate College he will neither engage in any outside employment for remuneration nor hold concurrently any other fellowship carrying a stipend.

Assistantships

Nominations to teaching and research assistantships originate in the department, and inquiry concerning opportunities available should be directed to the head of the department concerned. The minimum salary for a full-time assistant is $2,700 for nine months or $3,300 for the calendar year. However, the usual appointment is on a half-time basis at $1,350 for the academic year. An assistant whose salary is less than $2,700 for nine months or $3,300 for twelve months is exempt from tuition and incidental fees except the hospital and medical service fee of $5.00 each semester. Assistants must carry a reduced program of study as shown on page 17, but the additional length of time needed to complete the requirements for the degree desired is compensated by the gain in teaching or research experience.

Graduate assistantships for ten months with a stipend of $850 and exemption from tuition and fees are available to certain graduate students wishing residence hall experience in promoting successful group living, intelligent self-government, and optimum academic interests. Three units of graduate study may be pursued in counseling, guidance, or related fields, enabling the assistant to complete a master's degree in two semesters and a summer session. For further information, women may write to the Dean of Women, 100 Bevier Hall; male applicants should address the Assistant Dean of Students, 157 Administration Building (West), Urbana, Illinois.

The University of Illinois adheres to the following resolution adopted by the members of the Association of American Universities and a number of other graduate schools of North America:

"In every case in which a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or a prospective graduate student, the student, if he indicates his acceptance before April 15, will still have complete freedom through April 15 to

reconsider his acceptance and to accept another fellowship, scholarship, or graduate assistantship. He has committed himself, however, not to resign an appointment after this date unless he is formally released from it."

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 2,650,000 volumes, all except about 165,000 volumes being located in Urbana. The remainder are held by the Library of Medical Sciences in Chicago and the Undergraduate Division in Chicago.

In addition to the figures for cataloged volumes cited above, the University Library contains approximately 500,000 pamphlets, 160,000 maps, and 32,000 music scores and parts. More than 18,000 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archeology; sixteenth and seventeenth century English literature, especially the Milton-Shakespeare period; French, Italian, and Spanish literature; German literature of the sixteenth and seventeenth centuries; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

In the social sciences, the Library's holdings are significant for western United States history, Latin-American history of the Revolutionary period, Italian history, medieval and modern European history, German history for 1830-1900, Irish history, international law and relations, political science, law, economics, labor and industrial relations, and education.

For science and technology, collections of high rank are held in mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering, and agriculture.

The Library's bibliographical facilities comprise a union catalog of more than 3,000,000 cards, representing titles owned by about two dozen major American and foreign libraries; printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained. Following are the principal separately administered collections in the central library building: Classics; Commerce, Sociology, and Social Work; Education, Philosophy, and Psychology; English; Germanic and Romance Languages; History and Political Science; Library Science; and Physical Education.

Elsewhere on the campus are departmental libraries for the following fields: Agriculture, Architecture and Fine Arts, Chemistry, Engineering, Journalism, Landscape Architecture, Law, Mathematics, Music, Natural History (biological sciences, geology, and geography), Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine.

Further facilities available for graduate students are free access to the general bookstacks, housing about 1,500,000 volumes, and over 200 carrells in the bookstacks, assigned to individuals engaged in prolonged study and research. Interlibrary loan service from other institutions is provided for those engaged in research for dissertations.

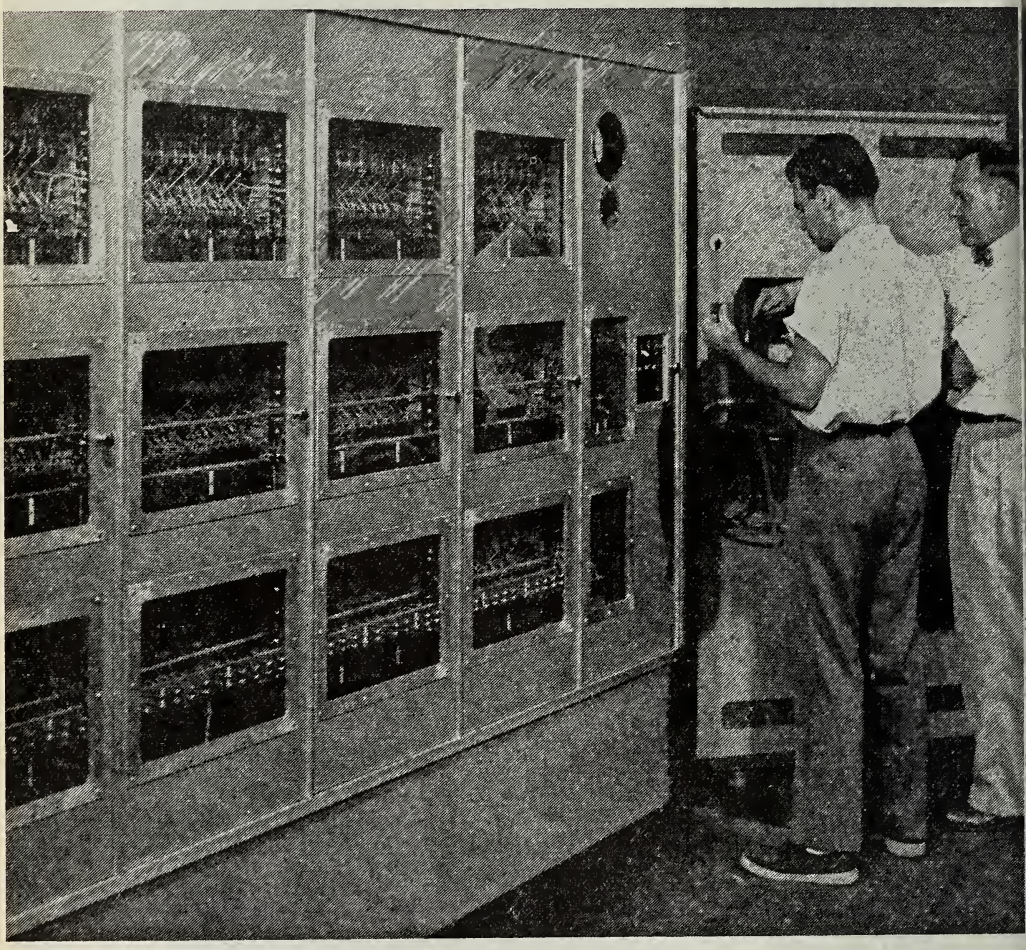
Special Laboratory Facilities

Digital Computer Laboratory. The Digital Computer Laboratory offers instruction in courses and supervision of theses for individuals specializing in the design and use of the digital computing machinery which is now of such importance in research work and in modern technology. The Laboratory possesses the Illiac, a high-speed general purpose computing machine which was built at the University of Illinois. Members of the staff who are engaged in computer research regularly offer four courses: Mathematics 383, 385, 457, and Mathematics (Electrical Engineering) 384. Descriptions of these courses are given under the appropriate department headings.

No advanced degree is offered by the Digital Computer Laboratory nor is there a curriculum in digital computers. However, candidates for advanced degrees in electrical engineering, mathematics, or physics, who are interested in this area of study, may engage in research under the supervision of one of the staff members in the Laboratory.

Active work in research is being carried out in the Boolean algebra of switching circuits, applied mathematics, computer circuits, and high-speed memories. A limited number of research assistantships are available for work carried out in the Laboratory. Requests for additional information concerning the work in the Laboratory and applications for assistantships should be directed to the Chairman of the Digital Computer Laboratory, 168 Engineering Research Laboratory, Urbana, Illinois.

Electron Microscope Laboratory. The Electron Microscope Laboratory is devoted to research work in behalf of all University departments. It is equipped with four different types of RCA electron microscopes, the original EMB, EMC (Console Type), EMT (table model with permanent magnet lenses), and a new EMU of latest design. These four



Candidates for advanced degrees whose projects require the use of a
speed digital computer may engage in research under the supervis
one of the staff members in the Digital Computer Laboratory.

microscopes with all auxiliary equipment are permanently located in an air-conditioned laboratory and their operation is under the direction of an expert electron micrographer.

Physical Environment Unit. The facilities of the Physical Environment Unit include rooms and an altitude chamber in which ranges of temperature, humidity, and pressure can be controlled, and basic medical and physiological instruments. They are available for use by any department or division of the University needing controlled environmental conditions for special research or instructional work. Although primarily designed for studies with human subjects and animals, the facilities can also be used for limited engineering and physical science activities.

Research assistantships, while not available in the Physical Environment Unit, are available in some of the departments interested in the effects of environment on people and animals. Inquiries regarding such assistantships should be sent to the department offering the specific work in which the student is interested.

Radiocarbon Laboratory. The Radiocarbon Laboratory, established in 1948 as an all-university facility, maintained and directed by a permanent staff, conducts research on chemical, physical, and biological problems by use of the tracer technique with carbon-14. Modern radiochemical equipment for the synthesis, degradation, isolation, and assay of radioactive carbon compounds is available.

A carbon-14 course, introducing radioactive carbon as a unique and potent tool of investigation and emphasizing experimental techniques, will soon be offered as a prerequisite for student research in the Laboratory.

Fees and Expenses

Students registering for resident work pay fees each semester or summer session according to the following schedules:

SEMESTER FEES

	Regular Schedule (*Over two units*)	*Reduced Schedule* (*Two units or less*)
Tuition Fee		
Residents of Illinois	$ 50.00	$16.00 per unit
Nonresidents of Illinois	160.00	44.00 per unit
Laboratory, Library, and Supply Fee	11.00	5.50

	Regular Schedule (Over two units)	*Reduced Schedule (Two units or less)*
Hospital and Medical Service Fee	5.00	5.00
Students who present evidence of participation in any other insurance system providing the same benefits as those covered by the University fee may petition the Dean of Students for refund of this fee. *Students registered for one unit or less are exempt from this fee.*		
Illini Union Service Charge	7.00	7.00
Students registered for one unit or less are exempt from this fee.		

SUMMER SESSION FEES

	Regular Schedule (Over one unit)	*Reduced Schedule (One unit or less)*
Tuition Fee		
Residents of Illinois	$ 25.00	$16.00 per unit
Nonresidents of Illinois	80.00	44.00 per unit
Laboratory, Library, and Supply Fee	5.50	2.75
Hospital and Medical Service Fee	2.50	2.50
Students registered for one-half unit or less are exempt from this fee.		
Illini Union Service Charge	3.50	3.50
Students registered for one-half unit or less are exempt from this fee.		

EXEMPTION FROM FEES

Holders of general scholarships are exempt from tuition fees only. University Fellows and all members of the academic and administrative staffs of the University may register for courses without payment of the tuition fee and the laboratory, library, and supply fee, provided their annual salary is less than the minimum salary for a full-time assistant ($2,700 for a nine-month appointment; $3,300 for a twelve-month appointment). Exempt under the same conditions are permanent employees on the nonacademic staff.

SPECIAL FEES

	Regular Schedule (Over one unit)	*Reduced Schedule (One unit or less)*
Late Registration Fee	$ 5.00	$ 5.00
Former students, whether on appointment or not, who register after the regular registration days in either semester are subject to this fee.		
Change of Program Fee		1.00
This fee is charged for every change slip issued later than the date shown on the Graduate College calendar.		

"In Absentia"

Students enrolled for thesis work for the master's or doctor's degree on leave of absence pay the regular tuition fee only, as listed above.

Professional Degrees 25.00

This fee is payable by candidates for professional degrees in Engineering each year.

Transcript Fee 0.50

Each student who has paid all his University fees is entitled to receive, without charge, one transcript of his record. For each additional transcript the fee is $0.50.

Service Charge for Deferred Fees

A service charge of ten per cent of the amount of fees deferred, but not to exceed $3.00 a semester, is assessed for the privilege of deferring fees. If deferred fees are paid in full within ten days after registration, the service charge is refunded except that a minimum service charge of $1.00 is retained by the University in all cases. The hospital and medical service fee, the Illini Union service charge, the service charge for deferring fees, and all charges from previous semesters must be paid on the day of registration.

EXPENSES

Although personal expenses may vary a great deal, the following estimates indicate the average cost for students: board, $12.00 to $15.00 a week; room rent, single rooms from $18.00 to $30.00 a month; double rooms from $15.00 to $20.00 a month for each person.

Housing

The University does not operate residence halls for graduate students. However, a limited number of one-room efficiency apartments for married students is available in the University-owned Student-Staff Apartment Building. Applications for these units may be obtained from the Housing Division or the Graduate College. In addition, the Director of Housing, 108 Illini Hall, maintains a list of small apartments and rooms available in private homes in the community.

Fields of Instruction

Courses open to graduate students are of two classes. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only.

Many courses for graduate students require some measure of previous preparation. By consultation with the adviser, a student may learn whether he has had the necessary prerequisites for a particular course.

The fellowships listed below under the various fields of instruction are specifically allocated to those fields. In addition, there are other fellowships not specifically assigned (see page 26).

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

An applicant's undergraduate grade-point average must be at least 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students on limited status will not be admitted.

Candidates who wish to make accountancy their major subject for an advanced degree must have had the equivalent of twenty hours of undergraduate work in accountancy and at least one course each in principles of economics and finance. Graduate students in other departments who choose accountancy as a minor must present similar courses, with fifteen instead of twenty hours in accountancy as a minimum. Students who can not meet these requirements will be expected to remove any deficiencies during the first year of residence by taking prescribed courses without graduate credit.

A first-year student whose major is accountancy ordinarily will be expected to take Accountancy 481 and 483.

A student who wishes to become a candidate for the Doctor of Philosophy degree with a major in accountancy must pass a preliminary examination showing a thorough knowledge of accounting theory; a thorough knowledge of certain areas of accountancy, the number and selection of which is to be determined by the adviser in consultation with the student; a general acquaintance with the subject matter and bibliography of other areas of accountancy; and proficiency in the field or fields outside the department offered as a minor or minors.

FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships are available in the Graduate College, as described in the beginning section of this catalog.

Part-time teaching assistantships are sometimes available for qualified students. Requests for application forms should be addressed to the Head of the Department.

GRADUATE TEACHING FACULTY

Professors: C. A. Moyer (Head of Department), H. H. Baily, R. I. Dickey, C. J. Gaa, R. K. Mautz, L. Morey, H. L. Newcomer.

Associate Professors: N. M. Bedford, W. E. Thomas, N. D. Wakefield.

Assistant Professors: H. E. Breen, J. M. Carrithers, Dorothy Litherland, K. W. Perry, A. R. Wyatt.

COURSES FOR GRADUATES

401. **General Accounting Theory.** Not for accountancy majors. A general presentation of accounting divested of the technicalities of bookkeeping, cost accounting, auditing, income tax procedure, so that it may provide graduate students, who have had or will secure a minimum of technical preparation in the subject, with a useful understanding of its basic ideas and limitations. Prerequisite: Consent of instructor. I; 1 unit. LITHERLAND.

424. **Specialized Systems.** Accounting procedures used by industrial and mercantile enterprises in handling their special problems; study of uniform accounting systems. I; 1 unit. BAILY.

427. **Accounting Techniques.** Analytical survey of application of accounting techniques to various special fields; accounting principles and procedures applied to governmental organizations, contractors, banks, insurance companies, manufacturing concerns, and other business activities. Credit is not allowed for this course in addition to credit for Accountancy 324, 341, and 366. I, II; 1 unit.

441. **Governmental Accounting.** Advanced study in accounting and other fiscal procedures of the federal government; state, county, and municipal governments; institutions. I; 1 unit. WAKEFIELD.

461. **Administrative Accounting.** Accounting as a tool for management — organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions, cooperation with public accountants and government agencies, and social responsibilities. I; 1 unit. THOMAS.

466. **Cost Accounting.** A critical examination of cost accounting methods as to truth and expediency. I; 1 unit. DICKEY.

471. **Accounting Reports.** Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. II; 1 unit. WAKEFIELD.

472. **Auditing Standards and Techniques.** A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. II; 1 unit. MOYER.

473. **System Design and Installation.** Problems and procedures in connection with designing and installing accounting systems. II; 1 unit. BAILY.

474. **Income Tax Development.** A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. II; 1 unit. GAA.

481. **Concepts and Principles.** The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. I; 1 unit. BEDFORD, MOYER.

483. **Income Determination.** A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. II; 1 unit. BEDFORD, MAUTZ.

484. **The Accounting Theory of Business Income.** An examination of the development and essential characteristics of the accounting theory of business income evaluated in the light of criticism implicit in other concepts of income; the social significance of business income theory. I; 1 unit. MAUTZ.

487. **Surplus and Dividends.** The theories underlying the treatment of balance sheet items deserve close consideration in accounting, because the balance

sheet reflects the effect of conflicting ideas about the bases for setting up restrictions on the freedom of directors to dispose of corporation assets as dividends. II; 1 unit. NEWCOMER.

489. **History of Accounting Theory.** An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. II; 1 unit. LITHERLAND.

491. **Thesis (M.S.).** Required of all students writing master's theses in accountancy. I, II; 1 unit. MAUTZ and others.

492. **Thesis (Ph.D.).** Required of all students writing doctor's theses in accountancy. I, II; 1 to 4 units. MOYER and others.

493. **Special Research Problems.** Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. I, II; ¼ to 2 units. MOYER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Advanced Accounting.** Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. I, II; ½ unit. Prerequisite: Accountancy 106 and 108. BEDFORD, BREEN, NEWCOMER, WYATT.

324. **Accounting Systems.** A discussion of the systems used by contractors, department stores, finance companies, building and loan associations, banks, insurance companies, brokers, water companies. I, II; ½ unit. Prerequisite: Accountancy 106 and 108. BAILY.

341. **Governmental Accounting.** Accounts of institutions, municipalities, and of state and federal governments; organization; procedure, budget, accounts and records, reports, audits. I, II; ½ unit. Prerequisite: Accountancy 108. BREEN.

362. **Business Budgets and Accounting Control.** Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. I, II; ½ unit. Prerequisite: Accountancy 108 (Accountancy 106 for students majoring in industrial administration). THOMAS.

366. **Advanced Cost Accounting.** Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. I, II; ½ unit. Prerequisite: Minimum of nine hours of accountancy including Accountancy 106. DICKEY.

371. **Auditing.** Ethics of the accounting profession; auditing standards and procedures; programs of audit of various accounts; construction and indexing of working papers; report to clients. I, II; ½ unit. Prerequisite: Accountancy 308. BREEN, MAUTZ, WYATT.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. I, II; ½ unit. Prerequisite: Accountancy 371. MAUTZ, MOYER, WAKEFIELD, WYATT.

374. **Advanced Income Tax Procedure.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. I, II; ½ to 1 unit. Prerequisite: Accountancy 274 and 308; senior standing. GAA.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. I, II; ½ to 1 unit. Prerequisite: Credit or registration in Accountancy 371. BEDFORD, MAUTZ, WAKEFIELD.

378. **C.P.A. Problems.** Selected problems from C.P.A. examinations; analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory, auditing, ethics. I, II; ½ to 1 unit. Prerequisite: Accountancy 377. Breen, Newcomer.

AERONAUTICAL ENGINEERING

The Department of Aeronautical Engineering offers graduate work leading to the degree of Master of Science in Aeronautical Engineering. The principal fields of study are aerodynamics, aircraft propulsion, and aircraft structures.

Students may apply for admission to graduate study in aeronautical engineering if they have a grade-point average of at least 3.5 for that portion of work which represents the last fifty per cent of the credits completed to secure the bachelor's degree exclusive of required physical education and military training. No student will be admitted on limited status.

The prerequisite for graduate study in aeronautical engineering is normally the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in aeronautical engineering. It is expected that graduate students with deficiencies in their aeronautical engineering background will demonstrate proficiency in the fundamentals of their chosen field by passing suitable courses or examinations to the satisfaction of their advisory committees.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Graduate students who desire to minor in aeronautical engineering must have taken mathematics through the first course in differential equations and undergraduate aeronautical engineering courses, equivalent to those offered at the University of Illinois, which are prerequisites to study in the branch of the subject in which the minor work is to be pursued. Where special cases warrant deviation from these requirements, approval from the Head of the Department is required.

ASSISTANTSHIPS

A limited number of part-time special research assistantships are available to well-qualified students pursuing graduate study in aeronautical engineering. Application forms for these assistantships may be obtained from the Department of Aeronautical Engineering.

GRADUATE TEACHING FACULTY

Professors: H. S. Stillwell (Head of Department), J. M. Coan, M. Z. Krzywoblocki, R. W. McCloy, T. P. Torda.
Assistant Professors: H. H. Hilton, A. I. Ormsbee.
Research Assistant Professor: C. H. Fletcher.

COURSES FOR GRADUATES

411. **Advanced Aerodynamics of Compressible Fluids.** Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. I; 1 unit. Krzywoblocki.

412. **Theory of Turbulence.** Introduction to the classical and modern theories of turbulence: Reynold's, Prandtl's, von Kármán's, von Kármán-Howarth's,

Kolmogoroff's, Heisenberg's, Krzywoblocki's theories in compressible fluids; Kampe de Feriet's theory. II; 1 unit. Prerequisite: Consent of instructor. KRZYWOBLOCKI.

414. **Advanced Theory of the Boundary Layer, Wakes and Jets.** The modern concepts and solutions of the boundary layer theory (laminar and turbulent), including considerations of transition and stability as well as the applications to wake and jet theories. II; 1 unit. Prerequisite: Consent of instructor. KRZYWOBLOCKI.

417. **Newtonian Flow and Elements of Missile Ballistics.** Fundamental concepts of Newtonian fluids; surface temperature of bodies in free molecular flow; equations of motion of a rocket during and after burning; properties of rocket functions; terrestrial and extra-terrestrial dynamics of rockets. I; 1 unit. Prerequisite: Aeronautical Engineering 306 and 411, or consent of instructor. KRZYWOBLOCKI.

421. **Analysis of Aircraft Shell Structures.** Advanced treatment of reinforced plate, box, and shell structures; effect of cutouts, taper, and sweepback on the analysis of wing structures; restrained warping; shear lag and diffusion of load. I; 1 unit. Prerequisite: Aeronautical Engineering 222 or consent of instructor. COAN.

426. **Theory of Continuous Media.** Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; the mechanism of deformation of single crystal and polycrystalline media; thermodynamic considerations. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or consent of instructor. HILTON.

431. **Aerothermodynamics.** The fundamental principles of classical and statistical thermodynamics as well as of fluid flow are treated. The laws of thermodynamics and aerodynamics are applied to problems, such as heat transfer by convection; heat transfer by conduction in laminar and turbulent flows; heat transfer in the boundary layer with fluid injection and suction. I; 1 unit. Prerequisite: Consent of instructor. TORDA.

432. **Aerothermodynamics.** Theories of flame propagation are discussed. Chemical kinetics of gaseous reactions and combustion of hydrocarbons are covered. Steady and non-steady flows with heat addition and some special topics are presented. II; 1 unit. Prerequisite: Consent of instructor. TORDA.

491. **Thesis.** Thesis in one of the fields of aeronautical engineering. I; 1 to 2 units. COAN, FLETCHER, HILTON, KRZYWOBLOCKI, MCCLOY, STILLWELL, TORDA.

492. **Thesis.** Thesis in one of the fields of aeronautical engineering. II; 1 to 2 units. COAN, FLETCHER, HILTON, KRZYWOBLOCKI, MCCLOY, STILLWELL, TORDA.

493. **Special Problems.** Theoretical and experimental investigations in the following fields: aerodynamics, aircraft propulsion, aircraft structures, and aircraft components. I; 1 to 2 units. COAN, FLETCHER, HILTON, KRZYWOBLOCKI, MCCLOY, STILLWELL, TORDA.

494. **Special Problems.** Theoretical and experimental investigations in the following fields: aerodynamics, aircraft propulsion, aircraft structures, and aircraft components. II; 1 to 2 units. COAN, FLETCHER, HILTON, KRZYWOBLOCKI, MCCLOY, STILLWELL, TORDA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Foundations of Mechanics and Gravitational Theory.** Same as Astronomy 306. Introduction of the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to earth, precession of earth's axis, etc. I; 1 unit. Prerequisite: Mathematics 142. MCVITTIE.

311. **Aerodynamics of Perfect Fluids.** Fundamental equations; plane irrotational flow; vortex flow; combination fields of flow; Kutta-Joukowski theorem; application of conformal transformation to fields of flow; particle paths; fields of flow relative to axes fixed in fluid; velocity potential; three-dimensional fields. I; ½ unit. Prerequisite: Aeronautical Engineering 211. Krzywoblocki.

316. **Stability and Control.** Advanced treatment of the dynamics of the airplane, airplane control, and airplane maneuverability. I; ½ unit. Prerequisite: Aeronautical Engineering 214; Mathematics 341 or 345. Stillwell.

331. **Combustion, Fuels, and Lubricants.** A study of the phenomena of combustion and combustion calculations; characteristics of fuels and lubricants for reciprocating engines, air-breathing jets, and rockets. I; ½ unit. Prerequisite: Mechanical Engineering 205; Aeronautical Engineering 232. McCloy.

332. **Aircraft Power Plant Design.** The aerodynamic and thermodynamic design of aircraft power plants including reciprocating engines, turbojets, pulse jets, ram jets, and rockets. II; ½ unit. Prerequisite: Aeronautical Engineering 233 and 331. McCloy.

334. **Rocket Propulsion and Rocketry.** The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. II; ½ unit. Prerequisite: First course in thermodynamics or consent of instructor. Torda.

391. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. I; ½ to 1 unit. Prerequisite: Senior standing in engineering; consent of instructor. Staff.

392. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. II; ½ to 1 unit. Prerequisite: Senior standing in engineering; consent of instructor. Staff.

393. **Theoretical Problems in Aeronautical Engineering.** This is a course flexible in specific content and providing an opportunity for broadening the student's understanding of analytical methods. Topics from the fields of aerodynamics, structures, mechanics, and propulsion will be chosen according to the student's interests and needs. I; ½ unit. Prerequisite: Senior standing; consent of instructor. Hilton, Torda.

AGRICULTURAL ECONOMICS

Graduate students may take work in agricultural economics leading to the degrees of Master of Science and Doctor of Philosophy. The chief fields of specialization are agricultural prices and statistics, farm management, land economics, marketing, and rural sociology. Work is also offered in economic policies, finance, and law as applied to agriculture, and in international comparative agriculture.

Graduate training in agricultural economics provides basic training for a wide range of employment, including agricultural economic teaching, research, or extension; a wide range of federal and state positions; foreign service; commercial marketing; professional farm management; credit with both public and private institutions; and with many private business institutions which employ men trained for positions requiring a thorough knowledge of the economics of agriculture.

Students who desire to secure degrees in agricultural economics must have completed either (1) a course of study equivalent to that required for the degree of Bachelor of Science in Agriculture at the University of Illinois, and including twelve hours of agricultural economics and economics, or (2) twelve hours of undergraduate economics and agricultural economics, and at least eight hours in accountancy, business law, history, management, marketing, political science, and sociology.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

A grade-point average of 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, is required for admission to graduate study. A student with a lower grade-point average may make up his deficiency by making satisfactory grades in twelve hours of additional undergraduate work in courses approved by the Head of the Department.

A candidate for the degree of Master of Science is required to register for at least two units in economics, including one unit of economic theory. For the degree of Doctor of Philosophy he must register for at least five units in economics, including two units of economic theory.

If approved by the Department of Agricultural Economics and the Dean of the Graduate College, the required work in economics may be treated as a part of the major field. Otherwise, the work in economics will be considered a first minor, in which case the program in that minor will require the approval of the Department of Economics (see requirements in economics for a minor in that field).

To take agricultural economics as a minor, the student must have had at least twenty hours of undergraduate work in economic and agricultural subjects.

ASSISTANTSHIPS

A number of part-time staff positions, both in research and teaching, are maintained. These provide practical training in research and teaching while a student is pursuing his graduate training. In general, these assistantships are granted to students with master's degrees or equivalent. Application blanks may be secured from the department.

GRADUATE TEACHING FACULTY

Professors: H. C. M. Case (Head of Department), R. W. Bartlett, H. W. Hannah, P. E. Johnston, G. L. Jordan, D. E. Lindstrom (on leave 1953-1955), L. J. Norton, R. C. Ross, C. L. Stewart, E. J. Working (on leave 1954-1955).

Associate Professors: C. L. Folse, R. J. Mutti, J. E. Wills.

Assistant Professors: W. D. Buddemeier, E. R. Swanson, W. N. Thompson (on leave 1954-1955), V. I. West.

COURSES FOR GRADUATES

401. **International Comparative Agriculture.** Agricultural and major food problems of various countries; procedures, national and international, for improved standards. I; 1 unit. Stewart.

404. **Economics of Agricultural Production.** Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. I; 1 unit. Swanson.

405. **Economic Policies and Programs Affecting Agriculture.** Economic analysis of state, national, and international policies and programs, including pro-

posed legislation having important bearing on the well-being of farm people. I; 1 unit. Prerequisite: One semester of graduate work or consent of department. NORTON and others.

418. **Land Economics.** Land classification methods and principles; land tenure systems in modern societies; land deterioration and restoration as private and public problems. II; 1 unit. STEWART.

425. **Farm Management Principles.** Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. I; 1 unit. JOHNSTON.

426. **Farm Management Investigational Methods.** History and development of farm management in the United States; critical analysis of research methods; use of random sampling; application of selected economic principles. II; 1 unit. JOHNSTON.

436. **Problems in Marketing Agricultural Products.** Factors influencing growth of markets; methods of cheapening and improving marketing processes; activities of government agencies; cooperative efforts. II; 1 unit. NORTON and others.

441. **Agricultural Prices and Statistics.** Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. I; 1 unit. Prerequisite: An elementary course in statistics. WORKING.

442. **Agricultural Prices and Statistics.** Prices of agricultural products in the light of their history, value theory, monetary theory, and methods of statistical analysis. II; 1 unit. Prerequisite: Agricultural Economics 441 or equivalent. WORKING.

477. **Rural Community Organization.** Same as Sociology 477. A study of rural community structure, functions, and processes, to give the student a concrete picture of how rural communities operate, and the forces which cause change in the group life of the people living in a rural community. I, II; 1 unit. BAUDER, FOLSE.

491. **Seminar.** Thesis course. Each graduate student whose major is agricultural economics must register in the course, but only those writing theses acceptable for graduate degrees will be given credit. I; 1 to 4 units. CASE and others.

492. **Seminar.** Thesis course. Each graduate student whose major is agricultural economics must register in the course, but only those writing theses acceptable for graduate degrees will be given credit. II; 1 to 4 units. CASE and others.

493. **Agricultural Economics Research.** Credit is conditional on completion of acceptable report of investigation. I; ½ to 2 units. CASE and others.

494. **Agricultural Economics Research.** Credit is conditional on completion of acceptable report of investigation. II; ½ to 2 units. CASE and others.

497. **Seminar in Rural Sociology.** Same as Sociology 497. The use of the scientific method in the study of rural social problems; an analysis of methods used in rural sociological research; an analysis of problems studied in rural sociology; guidance in carrying on research in rural sociology. II; 1 unit. BAUDER, FOLSE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Financing Agriculture.** Capital and credit needs of farmers; agencies supplying credit needs; problems of borrowers and lenders. II; ½ unit. Prerequisite: Economics 102 and 103, or 108. NORTON.

303. Agricultural Law. Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, and other problems involving agriculture. I, II; ½ unit. Prerequisite: Senior standing or consent of instructor. HANNAH.

305. **Agricultural Development and Policies.** Agricultural development in the United States presented as a basis for analyzing the effectiveness of past public agricultural policies, delineating agricultural problems, and the need of developing sound agricultural policies in keeping with a sound national economy. I; ½ to 1 unit. CASE.

312. **Farm Appraisals.** Same as Agronomy 312. Valuation of farm real estate; soils, crops, management, buildings, drainage, land titles, prices, and taxes in relation to value. Local field trips; estimated expense, $7. II; 1 unit. Prerequisite: Agronomy 201 and Agricultural Economics 220, or equivalent. STEWART and others.

324. **Farm Operation.** Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5. II; ½ unit. Prerequisite: Agricultural Economics 220. WILLS.

325. **Advanced Farm Management.** Planning the farm business for soil conservation and profit; fitting the livestock organization to the kind of crops produced and to market outlets; economic information for farm planning; measures of farm efficiency; labor and power problems. Field trips to study successful farms; estimated expense, $10. I; ½ unit. Prerequisite: Agricultural Economics 220. BUDDEMEIER.

331. **Grain Grading and Marketing.** Same as Agronomy 331 and Marketing 331. Factors affecting the quality of grain crops; standards employed in their classification and grading on the commercial market; laboratory practice in grain grading; a trip to a commercial grain grading laboratory; economic problems and market operations in grain marketing. I; ½ unit. Prerequisite: Agricultural Economics 230 and Agronomy 121, or consent of instructor. NORTON, WEIBEL.

332. **Livestock Marketing.** Same as Animal Science 332 and Marketing 332. Problems and practices in marketing livestock. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. KIRTLEY, NORTON.

333. **Marketing Horticultural Products.** Same as Horticulture 333 and Marketing 333. Producing and consuming areas; transportation; refrigeration; agencies, functions, and channels of distribution; cooperatives; marketing costs and factors affecting prices; standardization, grading, and inspection; marketing news service; perishable agricultural commodity act and other regulations; attempts to control surpluses; canning and other processing; foreign trade; consumer preference and expansion of domestic markets. I; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or five hours of horticulture, or consent of instructor. KELLY.

334. **Marketing Dairy Products.** Same as Dairy Science 334 and Marketing 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

341. **Agricultural Statistics.** A study of agricultural statistics and methods of statistics especially applicable to the fields of agricultural research. Students

receiving credit in this course will not receive credit in Agriculture 216. I; ½ unit. JORDAN.

342. **Agricultural Prices.** A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. JORDAN.

AGRICULTURAL EDUCATION

This is a program leading to the degree Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching vocational agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year General Agriculture Curriculum with Major for Teachers of Vocational Agriculture, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Education 311 and 312 and two of the following courses: Education 301, 302, 303, 304. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or, in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education. The courses in agriculture must, in general, be selected from at least three subject-matter departments with no more than three units from any one department.

A program of study suited to the student's objective will be suggested by the adviser from courses listed under the departmental headings.

A grade-point average of 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, is required for admission. Students on limited status will not be admitted to this program.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall, Professor H. M. Hamlin, 103 Gregory Hall, and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

The Department of Agricultural Engineering offers graduate work leading to the Master of Science degree in Agricultural Engineering, with options for specialization in farm power and machinery, soil and water engineering, farm structures, rural housing, and rural electrification.

Candidates for the master's degree must have had the equivalent of the undergraduate curriculum at the University of Illinois. This specifically includes basic training in theoretical and applied mechanics, and approximately twelve hours of advanced undergraduate design courses in civil engineering or mechanical engineering.

Students applying for admission must have a grade-point average of at least 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

FELLOWSHIPS AND ASSISTANTSHIPS

A few industrial fellowships are available. Requests for application forms should be directed to the Graduate College. Inquiries concerning part-time research or teaching assistantships should be directed to the Department of Agricultural Engineering.

GRADUATE TEACHING FACULTY

Professors: E. W. Lehmann (Head of Department), D. G. Carter, R. C. Hay (on leave 1954-1955), K. H. Hinchcliff (on leave 1954), G. E. Pickard, R. I. Shawl.
Assistant Professor: R. W. Kleis.
Associate: J. H. Ramser.

COURSES FOR GRADUATES

471. **Farm Structures in Agricultural Production.** Farm structures as related to production, farm operation, and systems of farming; building management, requirements, cost, and appraisal. I; ½ unit. Prerequisite: Bachelor's degree in agriculture. Carter.

491. **Thesis.** I, II; 1 to 2 units. Staff.

493. **Problems in Agricultural Engineering.** Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water engineering, and rural housing and farm structures. I, II; 1 unit. Prerequisite: Graduation in agricultural engineering or other engineering curricula, with credit in courses essential to the optional line of study; consent of head of department. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

331. **Function, Application, Adjustment, and Management of Farm Machinery.** A study of field and farmstead machinery as related to the needs of agricultural production, systems of farming, function, construction, maintenance, and operation cost. S; ½ unit. Offered in 1954 and in alternate years. Prerequisite: Agricultural Engineering 112 or 131, or consent of instructor. Shawl.

332. **Design of Agricultural Machinery.** Survey of needs and requirements, layout of design, estimation of cost, and study of production problems. II; ½ unit. Prerequisite: Mechanical Engineering 241. Pickard.

341. **Farm Power.** Basic theory, analysis, and testing of internal combustion engines specifically for use in farm tractors and other farm power requirements. I; ½ unit. Prerequisite: Mechanical Engineering 202. Pickard.

351. **Hydraulics of Soil Conservation.** Studies of watersheds, runoffs, cross sections of gullies; capacities of structures, terraces, and terrace outlets; design of structures; constructing terraces; machines used in erosion control; estimating costs and benefits of various methods of control. I; ½ unit. Prerequisite: Civil Engineering 115; Theoretical and Applied Mechanics 232 and 234; credit or registration in Civil Engineering 250; consent of instructor. Jones.

355. **Advanced Soil and Water Conservation Practices.** A study of conservation practices and their evaluation in relation to farm operations; planning, construction, and checking of terraces, waterways, diversion ditches, and drainage systems. S; ½ unit. Prerequisite: Agricultural Engineering 111 or 252, or consent of instructor. Jones.

361. **Development and Function of Family Housing.** Same as Home Economics 361. Study of principles and problem solutions in family housing; basic

functions, plan patterns, types, materials, and structures; economic influences, costs, and adaptations; personal and public interests. Lectures, discussions, and problems. II; ½ unit. CARTER.

371. **Advanced Farm Structures.** II; ½ unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223; Civil Engineering 261. CARTER.

381. **Farm Electrical Equipment.** Advanced course. Exploration and evaluation of the factors involved in the selection, arrangement, installation, and operation of equipment for applying electricity to farming operations. II; ½ unit. Prerequisite: Agricultural Engineering 241 or graduate standing in agriculture, or consent of instructor. KLEIS.

393. **Special Problems.** Each student chooses a special problem for design, laboratory, or field work with special library research. I, II; ½ unit. Prerequisite: Approval of head of department. STAFF.

AGRONOMY

The Department of Agronomy offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in soil fertility, soil physics, soil biology, plant breeding, soil productivity and management, crop pathology, and crop production.

Students who have a grade-point average of at least 3.75 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, may apply for admission to the Graduate College in agronomy. Students will not be accepted on limited status.

Fifteen semester hours in agronomy and related subjects are prerequisite for a minor and five additional hours for a major; but students with an unusually broad and thorough training in science may be exempted from certain of these requirements.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, bacteriology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics. A special pamphlet giving specific prerequisites and requirements may be obtained from the Head of the Department of Agronomy, 216 Davenport Hall.

A candidate for the Master of Science degree must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units will fulfill the requirements for a first minor for the Doctor of Philosophy degree.

ASSISTANTSHIPS

Teaching and research assistantships become available in the department from time to time. Information concerning these positions may be obtained from the Head of the Department of Agronomy, 216 Davenport Hall.

GRADUATE TEACHING FACULTY

Professors: M. B. RUSSELL (Head of Department), W. M. BEVER, O. T. BONNETT, R. H. BRAY, J. E. GIESEKING, R. W. JUGENHEIMER, B. KOEHLER, L. T. KURTZ, R. T. ODELL, O. H. SEARS, E. H. TYNER, C. M. WOODWORTH.

Associate Professors: E. B. EARLEY, J. A. JACKOBS, S. W. MELSTED, R. S. STAUFFER.

Assistant Professors: D. E. ALEXANDER, A. H. BEAVERS, A. W. BURGER, J. W. GERDEMANN, R. H. HAGEMAN, J. B. HANSON, C. N. HITTLE, A. KLUTE, E. R. LENG, F. W. SLIFE, F. J. STEVENSON.

COURSES FOR GRADUATES

401. **Soils Seminar.** I, II; ¼ unit. STAFF.

402. **Chemical Properties of Soils: Their Relation to Soil Development and Plant Growth.** Chemical properties of soils and soil materials; chemical aspects of soil development; their significance as factors in crop growth and plant nutrition. Discussion and assigned reading. I; 1 unit. Prerequisite: Adequate basic soils work. MELSTED.

405. **Colloidal Chemistry of Soils.** The nature and influence of various soil components on the physical, chemical, and electrokinetic properties of soils. II; 1 unit. Prerequisite: Chemistry 240 or equivalent. GIESEKING.

411. **Soil Physics.** The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. I; 1 unit. Prerequisite: Chemistry 240 or equivalent. KLUTE.

421. **Crops and Plant Breeding Seminar.** I, II; ¼ unit. STAFF.

422. **Pasture, Range, and Soil Conservation Research.** Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range, and to soil conservation. II; 1 unit. Prerequisite: Agronomy 121 and 321 or 322. JACKOBS.

423. **Theory and Analysis of Plant Breeding Problems.** Genetics of crop plants; problems in selection and hybridization. II; 1 unit. LENG.

424. **Principles Underlying the Production of Crops.** Study of crop production by consideration of vegetative and reproductive functions; water relations, respiration, factors affecting quality of seeds and other crop products, weeds, root reserves, stabilization of crop yields, and plant hormones. II; 1 unit. Prerequisite: One course in plant physiology or consent of instructor. HAGEMAN.

491. **Thesis.** I, II; ½ to 4 units.
(a) Soils. BEAVERS, BRAY, EARLEY, GIESEKING, KLUTE, KURTZ, MELSTED, ODELL, RUSSELL, SEARS, STAUFFER, STEVENSON, TYNER.
(b) Crops. BEVER, BONNETT, BURGER, GERDEMANN, HANSON, JACKOBS, JUGENHEIMER, KOEHLER, LENG, SLIFE, WOODWORTH.

492. **Research.** I, II; ½ to 4 units.
(a) Soils. BEAVERS, BRAY, EARLEY, GIESEKING, KLUTE, KURTZ, MELSTED, ODELL, RUSSELL, SEARS, STAUFFER, STEVENSON, TYNER.
(b) Crops. BEVER, BONNETT, BURGER, GERDEMANN, HANSON, JACKOBS, JUGENHEIMER, KOEHLER, LENG, SLIFE, WOODWORTH.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Genesis, Morphology, Classification, and Geography of Soils.** Factors governing and processes active in soil development; physical and chemical properties of the soil groups of the world; classification and nomenclature of soil; soil geography. Field trips to be arranged; estimated expense, $16. II; ½ unit. Prerequisite: Agronomy 201. BEAVERS.

302. **Role of Microorganisms in Soil Fertility.** Microorganisms of the soils in relation to fertility; nitrogen fixation, assimilation, and preservation. I; ½ unit. Prerequisite: Agronomy 201. SEARS.

303. **Soil Productivity, Its Variation, Modification, and Conservation.** Factors affecting soil productivity and its conservation; soil type response; influence of cropping systems, fertilizers, and management practices on productivity trends. II; ½ unit. Prerequisite: Agronomy 201.

304. **Soil Microbiology.** Isolation, cultivation, and metabolism of specific groups of soil microorganisms; transformations of nitrogen in soils; biochemistry of nitrogen fixation; the carbon cycle; relationship of soil conditions to the distribution and biochemical activity of the soil microflora. Resultants of the interaction of soil microorganisms are considered. II; 1 unit. Prerequisite: Bacteriology 104; Chemistry 132. SEARS, STEVENSON.

305. **Laboratory in Soil Physics.** Introductory and advanced laboratory experiments illustrating principles and methods of physical studies of soils. The work is graded according to the previous training of the student. I; ½ unit. Prerequisite: Agronomy 201 or equivalent; consent of instructor. KLUTE, STAUFFER.

306. **Fertilizers and Their Soil Reactions.** Fertilizer sources and materials. Chemical forms of elements in the soil, reactions of fertilizers in soils, determination of fertilizer needs, soil test methods, fertilizer application. I; ½ unit. Prerequisite: Agronomy 201. BRAY.

307. **Principles of Soil Conservation.** National and local implications of soil conservation and its relation to farming systems, land management, climate, soil character, and farming operations. II; ½ unit. Prerequisite: Agronomy 121 and 201. STAUFFER.

308. **Plant Composition and Chemurgy.** Synthesis, general chemistry, and principal sources of carbohydrates, oils, and proteins; chemical composition of agronomic plants as affected by rate and date of planting and by nutritional, environmental, and genetic factors; relation of plant composition to utilization. II; ½ unit. Prerequisite: Chemistry 132 or equivalent; Agronomy 121; Agronomy 201 or consent of instructor. EARLEY.

311. **Physical Edaphology.** The underlying principles of the influence of physical properties of soils on plant growth; the application of these principles to practical problems of tillage, drainage, conservation, and plant nutrition. II; ½ unit. Prerequisite: Agronomy 201. RUSSELL.

312. **Farm Appraisals.** Same as Agricultural Economics 312. Valuation of farm real estate; soils, crops, management, buildings, drainage, land titles, prices, and taxes in relation to value. Local field trips; estimated expense, $7. II; I unit. Prerequisite: Agronomy 201 and Agricultural Economics 220, or equivalent. STEWART and others.

317. **Plant Pathology.** Same as Botany 317, Horticulture 317, and Plant Pathology 317. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science including Botany 100. BLACK.

321. **Crop Production as Affected by the Environment.** Response of crop plants to their habitat; study of climatic, physiographic, edaphic, and biotic factors of the environment in relation to crop growth; means by which crop hazards may be reduced. I; ½ unit. Prerequisite: Agronomy 121. HANSON.

322. **Forage Crops and Pastures.** Lectures and discussions of roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. II; ½ unit. Prerequisite: Agronomy 121. JACKOBS.

323. **Improvement of Farm Crops by Breeding.** Heredity and variation in crop plants; effects of self-fertilization and cross-fertilization; principles and results of selection and hybridization in crop improvement. I; ½ unit. Prerequisite: Agronomy 110 or equivalent; Agronomy 121. BONNETT.

324. **Principles of Field Plot Experimentation.** Purposes, methods, and principles of field experimentation; interpretation of results. II; ½ unit. Prerequisite: One semester of statistics or biometry, or equivalent. LENG.

325. **Corn Breeding.** Principles and procedures involved in developing, testing, and production of inbred lines and hybrids; production and processing of hybrid seed corn; genetics of corn. II; ½ unit. Prerequisite: Agronomy 110. JUGENHEIMER.

326. **Weeds and Their Control.** Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. Field trip to be arranged; estimated expense, $5. I; ½ unit. Prerequisite: Agronomy 121. SLIFE.

327. **Forage Crop Breeding.** Principles and methods of plant breeding as related to forage crops: sources of hereditary variation, identification of desirable types, methods of evaluating breeding materials, and the utilization of desirable variations will be discussed; cytological, genetical, and breeding investigations of the more important forage species and the development of improved varieties will be considered. I; ½ unit. Prerequisite: Agronomy 110 or equivalent; Agronomy 323 or consent of instructor. HITTLE.

331. **Grain Grading and Marketing.** Same as Agricultural Economics 331 and Marketing 331. Factors affecting the quality of grain crops; standards employed in their classification and grading on the commercial market; laboratory practice in grain grading; a trip to a commercial grain grading laboratory; economic problems and market operations in grain marketing. I; ½ unit. Prerequisite: Agricultural Economics 230 and Agronomy 121, or consent of instructor. NORTON, WEIBEL.

377. **Diseases of Field Crops.** Same as Botany 377 and Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Agronomy 317 or consent of instructor. BEVER, GERDEMANN.

379. **Research Methods in Plant Pathology.** Same as Botany 379, Horticulture 379, and Plant Pathology 379. Lectures and laboratory techniques for isolation, for culture of and inoculation with plant pathogens, for the evaluation of plant protectants; for the study of the physiology of parasitism and methods of evaluation of data and preparation of manuscripts. I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Agronomy 317. GERDEMANN, GOTTLIEB.

ANIMAL SCIENCE

(Including Animal Nutrition)

The Department of Animal Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Animal Science and in Animal Nutrition. For a major or a minor for the master's degree, the student may specialize in the general field of livestock or poultry production, or in the special fields of animal genetics and physiology, animal nutrition, or meats. For a major or minor for the doctor's degree he may specialize in animal genetics and physiology, animal nutrition, or in the general field of animal science.

The minimum grade-point average for admission to graduate study in the department is 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

A student who wishes to register for a minor in animal science for either the master's or doctor's degree must offer at least fifteen college credits in the field, including the principles of feeding, the principles of genetics, and livestock production and management, and he must have had an introductory course in

organic chemistry. For a major, a student must offer at least five additional college credits in animal science or in courses related to his major field of specialization. To qualify for graduate study in the field of meats, a student must offer credit in Animal Science 104, 204, and 205, or their equivalents. Besides these general requirements, a student must have had the special training necessary for effective graduate study in the field of his chosen major.

Introductory courses in physiology and zoology, and in mathematics prerequisite to or including statistics, are desirable preparation for graduate work in any phase of animal science or animal nutrition. A reading knowledge of French and German, if acquired prior to registration in the Graduate College, will avoid the necessity of devoting time to these subjects while also carrying course work in the student's special field of interest.

Students who take a major or a minor for the doctor's degree in the general field of animal science must take Animal Nutrition 401 and a course in animal genetics if they have not previously taken these courses or their equivalents. All students taking a major or a minor in Animal Science are expected, while in residence, to attend and participate in Animal Science 400, Seminar, and must register in the course for a minimum of two semesters.

ASSISTANTSHIPS

Some research and teaching assistantships are available to students who can qualify for a major and who have a scholastic record of 4.0 or better. Applications should be addressed to the Head of the Department.

GRADUATE TEACHING FACULTY

Professors: L. E. Card (Head of Department), S. Bull, T. S. Hamilton, B. C. Johnson, H. H. Mitchell, A. V. Nalbandov, E. Roberts, H. M. Scott.

Associate Professors: D. E. Becker, R. M. Forbes, U. S. Garrigus, A. L. Neumann, S. W. Terrill.

Assistant Professors: J. V. Craig, H. H. Draper, A. H. Jensen, S. P. Mistry.

COURSES FOR GRADUATES

400. **Seminar.** A review of current literature in the science of animal production. I, II; ¼ unit. Staff.

401. **Special Problems in Beef Production.** A critical study of beef cattle experiments and the interpretation of their results. Intended to prepare students for positions with agricultural colleges and experiment stations and the United States Department of Agriculture. II; 1 unit. Prerequisite: Consent of instructor. Neumann.

402. **Problems in Sheep and Wool Production and Research.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. Intended to aid in preparing students for positions in colleges, experiment stations, and related fields. II; ½ unit. Prerequisite: Consent of instructor. Garrigus.

403. **Special Problems in Swine Research.** A critical study and interpretation of experiments in swine feeding, breeding, and management. Intended to aid in preparing students for positions in colleges, experiment stations, and related fields. II; ½ unit. Prerequisite: Consent of instructor. Terrill.

404. **Special Problems in Poultry Husbandry.** A discussion of research methods and findings in the field of poultry science, with some consideration of current industry problems. I; ½ unit. Prerequisite: Consent of instructor. Scott.

405. **Advanced Animal Genetics.** Genetic theory, analysis of animal breeding problems, genetic results of selection and different systems of breeding. I; 1 unit. Craig.

406. **Physiology of Reproduction.** Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. II; 1 unit. Nalbandov.

407. **Laboratory Methods in Animal Genetics.** I or II; ½ to 1 unit. Craig.

408. **Laboratory Methods in Physiology of Reproduction.** I or II; ½ to 1 unit. Nalbandov.

411. **Population Genetics and Animal Breeding.** Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals. Results of different systems of mating and the expected gains from different methods of selection. II; 1 unit. Prerequisite: Animal Science 110 or equivalent. Touchberry.

491. **Research and Thesis.** Work may be taken in the following subjects: factors in livestock production, animal genetics, animal physiology, poultry, and meats. I, II; ½ to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Beef Production.** The principles of feeding and management of beef cattle; financial aspects of beef production; diseases and parasites of beef cattle; fitting cattle for show and sale. Lectures and discussions. I, II; ¾ unit. Prerequisite: Animal Science 102. Neumann.

302. **Sheep Production.** The sheep and wool industries; principles and practices of various phases of production. II; ¾ unit. Prerequisite: Animal Science 102. Garrigus.

303. **Pork Production.** The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. I, II; ¾ unit. Prerequisite: Animal Science 102. Becker, Jensen.

304. **Poultry Management.** Poultry science and practice with special reference to the place of the poultry enterprise on Illinois farms. I, II; ¾ unit. Prerequisite: Animal Science 102. Scott.

305. **Genetics and Animal Improvement.** Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement. II; ¾ unit. Prerequisite: Animal Science 100 or equivalent. Craig, Touchberry.

332. **Livestock Marketing.** Same as Agricultural Economics 332 and Marketing 332. Problems and practices in marketing livestock. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. Kirtley, Norton.

Animal Nutrition

The Division of Animal Nutrition offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. The areas of study within the division include the nutritive requirements of various species of animals and of man, with particular reference to farm animals, the nutritive evaluation of farm feeds and human foods by chemical analysis and appropriate animal assays, and the functions of food energy, proteins, carbohydrates, fats, and minerals and the micronutrients, minerals and vitamins, in the animal organism.

The minimum grade-point average for admission to graduate study in animal nutrition is 3.5 for that portion of work which represents the last fifty per cent of

the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

To qualify for a major in this field, a student must have an adequate training in chemistry (including five hours of organic chemistry, five hours of analytical chemistry, and preferably five hours of agricultural biochemistry or food analysis, and five hours of physical chemistry) and in mathematics, including, or prerequisite to, statistics. Introductory courses in physiology and bacteriology, and in French and German, are desirable prerequisites for a major in animal nutrition. For a first minor, three hours of organic chemistry and five hours of agricultural biochemistry or of quantitative chemical analysis are required. For a second minor, only the prerequisites for the selected courses in animal nutrition need be offered.

ASSISTANTSHIPS

Some research and teaching assistantships are available in animal nutrition to students who can qualify for a major in the field and who have made an acceptable scholastic record (4.0 average or better) in undergraduate or graduate work. Applications should be addressed to the Head of the Department or to the Head of the Division.

COURSES FOR GRADUATES

401. **Principles of Animal Nutrition.** Physical and chemical properties of nutrients; digestion and metabolism; functions and utilization of nutrients; principles involved in determining the nutritive requirements of animals. I; 1¼ units. Prerequisite: Chemistry 122 or 124, 133 or 234. Hamilton.

402. **Advanced Course in Animal Nutrition.** A factorial study of the nutrient requirements of animals and man, and of the net nutritive values of feeds and food materials; comparative nutrition. II; 1¼ units. Prerequisite: Animal Nutrition 401 or equivalent.

403. **Laboratory Methods in Animal Nutrition.** Techniques of animal nutrition investigations. I, II; 1 unit. Forbes.

405. **Animal Nutrition Seminar.** I, II; ½ unit. Staff.

407. **Vitamins in Nutrition.** Nutritional requirements for individual vitamins; physiological function; metabolism and deficiency symptoms in different species. I; 1 unit. Prerequisite: Animal Nutrition 401 or Chemistry 350, or equivalent. Johnson.

408. **Laboratory Methods in Vitamin Nutrition.** Experiments designed to acquaint students with methods of research in the vitamin field. I, II; ¼ to 1 unit. Prerequisite: Animal Nutrition 407 or Chemistry 352, or equivalent. Johnson.

491. **Research and Thesis.** I, II; ½ to 4 units. Forbes, Hamilton, Johnson, Mitchell.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Animal Nutrition.** For students whose major is not animal nutrition, but who desire an introduction to the principles and practical applications of the science to animal feeding. II; ¾ unit. Prerequisite: Animal Science 102; Chemistry 132. Forbes.

304. **Methods of Vitamin Assay.** A study of the principles underlying chemical, biological, and microbiological methods for the assay of vitamins, and the technical procedures that have been developed for this purpose. II; ½ to 1 unit. Prerequisite: Chemistry 350 or equivalent; consent of instructor. Johnson.

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ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the degrees of Master of Science in Architecture and in Architectural Engineering. Majors are offered in architectural design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles), advanced structural theory and design, and the history of architecture.

Students applying for admission must have a grade-point average of at least 3.5 for that portion of the work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Limited status students may be admitted.

The prerequisite for graduate work in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of this University. The prerequisite for graduate work in architectural engineering is a bachelor's degree in architectural engineering. A major consists of four units and a minor of one unit.

ASSISTANTSHIPS

A few teaching assistantships are available to graduate students in architecture and architectural engineering. Inquiry regarding such appointments should be addressed to the Chairman of the Department.

GRADUATE TEACHING FACULTY

Professors: A. K. Laing (Chairman of Department), T. C. Bannister, W. S. Kinne, Jr., E. I. Love, C. E. Palmer, A. M. Richardson, C. K. Wang.

COURSES FOR GRADUATES

401. **Architectural Construction.** Special problems. I, II; ½ to 2 units. Prerequisite: A degree in either option offered by the Department of Architecture. Kinne, Palmer.

403. **Architectural Construction.** Theory and design. I, II; ½ to 2 units. Prerequisite: The degree in architectural engineering offered by the Department of Architecture, or the equivalent. Wang.

404. **Architectural Design.** Advanced course. I, II; 1 to 3 units. Prerequisite: The degree in architecture offered by the Department of Architecture, or the equivalent. Richardson.

406. **Architectural History.** Special research. I, II; ½ to 2 units. Prerequisite: A degree in either option offered by the Department of Architecture. Bannister, Laing.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Architectural Design.** Advanced problems in modern buildings and building groups with complex requirements. I, II; 1½ units. Prerequisite: Architecture 236. Love.

338. **Architectural Design.** Advanced problems in modern buildings and building groups with complex requirements. I, II; 1½ units. Prerequisite: Architecture 337. Love.

347. **Theory of Structures.** Analysis of framework; industrial buildings; churches; arches; deflections; the elastic theory. I, II; 1 unit. Prerequisite: Architecture 246; Theoretical and Applied Mechanics 221; credit or registration in Architecture 257. Link.

48. **Advanced Structures.** Theaters, assembly halls, and high buildings; continuous beams and trusses; rigid frames; statically indeterminate structures. I, II; 1 unit. Prerequisite: Architecture 347; credit or registration in Architecture 358. WANG.

58. **Reinforced Concrete Design.** Reinforced concrete building design; analysis of various types of modern fireproof construction. I, II; ½ unit. Prerequisite: Architecture 257; credit or registration in Architecture 348. WANG.

ART

The Department of Art offers graduate work leading to the degrees of Master f Fine Arts (creative art) and Master of Arts (art education and art history). The prerequisite for graduate work leading to these degrees is the Bachelor of ine Arts degree as established at this University with a concentration in the field o be pursued in graduate study, or its equivalent.

Students applying for admission must have a grade-point average of 3.5 based n that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students will not be admitted on limited status.

Admission to the Graduate College does not make the student a candidate for n advanced degree in the department until he has been accepted as such by the Departmental Graduate Committee. Upon application to the Graduate College, nformation on departmental procedures and requirements should be obtained by vriting to the Chairman of the Department of Art. Prospective students expecting o do graduate work leading to the Master of Fine Arts degree must submit original examples of their work to the Departmental Graduate Committee in advance f registration. Students expecting to pursue study leading to the Master of Arts legree in art education must have or be eligible for a teaching certificate in their ield. In order to determine eligibility for graduate study, prospective students nust submit, for examination, a transcript of their undergraduate credits to the Chairman of the Department. In the event that a prospective candidate for any legree in the department is found to be deficient in any professional phase of ndergraduate training, the Committee will require the student to take such ndergraduate courses as will remove the deficiency.

Not later than mid-point in the student's proposed program, the candidate vill be given a qualifying examination in order to determine his status in terms of rogress, ultimate completion, and awarding of the degree. The Committee may xtend the residence requirement (or increase the total unit requirements) at this ime or any other time, if this seems warranted. The student will be recommended or the degree after a final review or examination.

The thesis required for the Master of Fine Arts degree is an original work of reative art, accompanied by a written report, while the thesis for the Master of Arts degree with a major in art history is a written document. The thesis remains he property of the University, as do such other works designated by the Departnental Graduate Committee.

Degree of Master of Fine Arts with Design Major. To qualify for the degree f Master of Fine Arts, with a major in design, each student is required to complete satisfactorily all of the following courses to the minimum of twelve units: Art 491, one to three units; Art 493, one unit; Art 477, four to six units; art history (two courses elected from the group Art 311 through 318), one and one-half units; art electives (Art 333, 341, 351, 355, 371, 372, 494, and art history), wo or three units. A thesis is required.

Degree of Master of Fine Arts with Painting and Graphics Major. To qualify or the degree of Master of Fine Arts, with a major in painting and graphics, each

student is required to complete satisfactorily all of the following courses to the minimum of twelve units: Art 341, one-half unit (substitution of credit in other courses may be made for this subject by permission of the Departmental Graduate Committee); Art 491, one to three units; Art 493, one unit; Art 495, two to six units; Art 497, one-half to six units; art history (two courses elected from the group Art 311 through 318), one and one-half units; art electives (Art 351, 371, 372, 494, and art history), two units. A thesis is required.

Degree of Master of Arts with Art Education Major. To qualify for the degree of Master of Arts, with a major in art education, each student is required to complete satisfactorily all of the following courses to the minimum of eight units: Art 493, one unit; art history (one course elected from the group Art 311 through 318), three-fourths unit; art electives, two and one-fourth units; Education 311, one-half unit; Education 312, one-half unit; Education 456, one unit; two of the following: Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required.

Degree of Master of Arts with Art History Major. To qualify for the degree of Master of Arts, with a major in art history, each student is required to complete satisfactorily all of the following courses to the minimum of eight units: Art 341, one-half unit; Art 493, one unit; Art 494, one to four units; art history (elected from the group Art 311 through 318), one and one-half to three units; electives, one or two units. A thesis is required.

ASSISTANTSHIPS

A limited number of assistantships are available. Applications should be made directly to the Chairman of the Department of Art.

GRADUATE TEACHING FACULTY

Professors: C. V. Donovan (Acting Chairman of Department), C. E. Bradbury, W. F. Doolittle, J. D. Hogan, J. W. Kennedy, F. J. Roos, H. A. Schultz, J. R. Shipley, A. S. Weller.

Associate Professors: C. A. Dietemann, M. B. Martin, A. J. Pulos, E. C. Rae.

Assistant Professors: L. R. Chesney, N. Ziroli.

COURSES FOR GRADUATES

467. **Advertising Design Laboratory.** Individually directed research in advertising design. I, II; 1 to 2 units. Staff.

477. **Industrial Design Laboratory.** Individually directed research in industrial design. I, II; 1 to 2 units. Shipley.

491. **Special Problems.** Individual direction in research and in creative activity; thesis. I, II; 1 to 2 units. Staff.

493. **Seminar.** Introduction to research. I; 1 unit. Roos, Weller.

494. **Studies in Art History and Criticism.** Individual study of special periods of art history; intensive reading of selected critical works; the writing of art criticism. II; 1 to 2 units. Rae, Roos, Weller.

495. **Painting Laboratory.** Professional and experimental painting with emphasis on the development of maturity of style and personal expression. I, II; 1 to 2 units. Staff.

497. **Graphic Workshop.** Intaglio printing, including etching, engraving, and aquatint. I, II; 1 to 2 units. Chesney.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Classical Art.** Architecture, painting, sculpture, and minor arts of the Greek and Roman periods. I or II; ¾ unit. Offered in 1954-1955 and in alternate

years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

312. **Medieval Art.** Architecture, painting, sculpture, and minor arts of the Romanesque and Gothic periods. I or II; ¾ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

313. **Italian Renaissance Art.** Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. I or II; ¾ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Weller.

314. **Northern Renaissance Art.** Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. I or II; ¾ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Weller.

315. **Art of the Nineteenth Century.** Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. I or II; ¾ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

316. **Art of the Twentieth Century.** Architecture, painting, sculpture, and minor arts of the twentieth century in France, Germany, Spain, and England. I or II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

317. **American Art.** Architecture, painting, sculpture, and minor arts of the colonies and the United States. I or II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

318. **Latin-American Art.** A study of the more important phases and periods of the visual arts of Latin America. I or II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

333. **Painting.** Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts degree in painting. I, II; ½ to 1 unit. Prerequisite: Art 142 or equivalent. Staff.

341. **Painting Materials and Techniques.** Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. I or II; ½ unit. Prerequisite: Art 142 or graduate standing in art. Kennedy.

351. **Advanced Sculpture Techniques.** Advanced work in various sculptural media. I, II; ½ to 1 unit. Prerequisite: Art 252 or equivalent. Martin.

355. **Graphic Media.** Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts degree in painting. I, II; ½ to 1 unit. Prerequisite: Art 256 or equivalent. Chesney.

371. **Silversmithing, I.** Design and execution of hollow ware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. I, II; ½ unit. Prerequisite: Art 172 or equivalent. Pulos.

372. **Silversmithing, II.** Design and execution of flatware and hollow ware, dealing primarily with forging and seaming methods, engraving, and toolmaking. I, II; ½ unit. Prerequisite: Art 371. Pulos.

ASTRONOMY

The Department offers graduate work leading to the degree of Master of Science in the theoretical aspects of astronomy. The admission requirements for

graduate study in astronomy are the general regulations governing admission of all graduate students, a major in either mathematics or physics, and a year's course in descriptive astronomy, e.g., Astronomy 201 and 202. The eight units required for the degree of Master of Science are to be secured in the following way: (1) two units to be obtained by selecting one out of the following pairs of courses in Mathematics 341 and 342, 343 and 345, 458 and 459; (2) two units to be obtained by selecting one out of the following three pairs of courses in physics: 321 and 322, 371 and 381, 400 and 422; (3) four units to be obtained by selection from the courses in astronomy listed below.

GRADUATE TEACHING FACULTY

Professor: G. C. McVittie (Head of Department).
Assistant Professor: S. P. Wyatt.

COURSES FOR GRADUATES

403. **Dynamics of the Earth's Atmosphere.** Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

404. **Theory of Stellar Structure.** Mathematical theory of the internal equilibrium of a gaseous star under the action of gravity, gas pressure, and radiation pressure; types of stars; source of stellar energy. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

424. **Relativity and Cosmology.** Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. McVittie.

491. **Seminar in Special Topics.** I, II; 1 to 4 units. Prerequisite: Consent of instructor. McVittie.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Foundations of Mechanics and Gravitational Theory.** Same as Aeronautical Engineering 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to earth, precession of earth's axis, etc. I; 1 unit. Prerequisite: Mathematics 142. McVittie.

307. **Celestial Mechanics.** Celestial sphere and spherical trigonometry; dynamical theory of planetary motion; celestial coordinate systems; parallax and distance determination; orbits of double stars; high-velocity stars and spiral structure of a galaxy. II; 1 unit. Prerequisite: Astronomy 306 or Physics 322. McVittie.

314. **Observational Astronomy.** Lectures and observing. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to the theory of errors; theory and practice of astronomical photography. II; 1 unit. Prerequisite: Consent of instructor. Wyatt.

BACTERIOLOGY

The Department of Bacteriology offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. Students electing bacteriology as a

najor for an advanced degree must have had, in addition to formal training in general bacteriology, chemistry through quantitative analysis and organic chemstry, and fifteen hours of physical or biological sciences. Mathematics through alculus is strongly recommended.

Students who have fulfilled these course requirements may apply for admision if they have a grade-point average of at least 4.0 for that portion of work vhich represents the last fifty per cent of the hours completed to secure the achelor's degree, exclusive of required physical education and military training. No students on limited status will be admitted.

Candidates for the degree of Master of Science must pass a general written comprehensive examination toward the close of the second semester of residence.

ASSISTANTSHIPS

There are a number of teaching assistantships available to graduate students n bacteriology. Some research assistantships and industrial fellowships are availble in the department. These are generally awarded to students who have been enrolled in graduate work in the Department of Bacteriology for one or more years.

GRADUATE TEACHING FACULTY

Professors: H. O. Halvorson (Head of Department), I. C. Gunsalus, S. E. Luria, S. Spiegelman, G. I. Wallace.
Associate Professor: F. M. Clark.
Assistant Professor: E. Juni.

COURSES FOR GRADUATES

404. **Quantitative Analysis of Bacteriology Procedures.** Quantitative analysis of counting methods, antibiotic assay methods, vitamin assay methods, analysis of growth and death curves, methods of measuring mutation frequency, and quantitative aspects of epidemiology. I; 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Bacteriology 300; consent of instructor. Halvorson, Spiegelman.

405. **Microbiological Genetics.** Study of the phenomenon of heredity in microorganisms with particular reference to recent developments in the field. Examples from protozoa, yeasts, molds, bacteria, and viruses will be considered. Emphasis will be placed on critical examination and evaluation of methods. Implications of results for fundamental aspects of gene functions will be considered. II; ¾ unit. Prerequisite: Genetics (Botany 322 or Zoology 351); mathematics through calculus, or consent of instructor. Spiegelman.

420. **Chemistry of Microbic Processes.** The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimilation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns will be included. II; ¾ unit. Prerequisite: Bacteriology 300 or equivalent; Chemistry 234 or equivalent; Chemistry 350 or equivalent; consent of instructor. Gunsalus.

425. **Bacterial Metabolism.** Laboratory. This course is designed to give a working knowledge of the methods currently employed in the study of the chemical aspects of microorganisms. Experiments will include the analysis of fermentation mixtures, the metabolic properties of microorganisms and the enzymes involved as illustrated with resting cells, cell preparations, and cell-free enzymes. The application of manometric, colorimetric, and isotopic methods to the study of microorganisms and the purification of microbic enzymes will be

included. I; ½ unit. Prerequisite: Bacteriology 420; consent of instructor. GUNSALUS.

451. **Experimental Virology.** Experiments to illustrate the main properties of viruses. II; ¾ unit. Prerequisite: Credit or registration in Bacteriology 351; consent of instructor. LURIA.

493. **Research.** I; ½ to 4 units. STAFF.

494. **Research.** II; ½ to 4 units. STAFF.

495. **Discussions of Current Problems in Bacteriology.** Required of all graduate students whose major is bacteriology. I; 0 to ¼ unit. Prerequisite: Ten hours of bacteriology; consent of instructor. STAFF.

496. **Discussions of Current Problems in Bacteriology.** Required of all graduate students whose major is bacteriology. II; 0 to ¼ unit. Prerequisite: Ten hours of bacteriology; consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Microbiology.** Emphasis is placed on the fundamental concepts and techniques of microbiology; isolation, cultivation, and observation of bacteria. The morphology, physiology, and nutrition of microorganisms; their role in nature, and infection and immunity will be considered. I, II; 1 unit. Prerequisite: A college course in general botany or zoology; chemistry through organic. JUNI.

306. **Principles of Experimental Bacteriology.** A study of the experimental basis of bacterial physiology, cytochemistry, and variation; the conditions which influence metabolism, growth, and death; the properties of the bacterial cell and the bacterial culture. Laboratory experiments are designed to illustrate the principles of experimentation as applied to microorganisms. I; 1 unit. Prerequisite: Bacteriology 300; Chemistry 124 and 234, or equivalent. GUNSALUS, LURIA.

308. **Food and Industrial Microbiology.** The relationship of microorganisms to food manufacture and preservation, and to industrial fermentation and processing. The laboratory will consider the properties of the bacteria, yeasts, molds, and actinomyces of importance to industrial processes and methods of control. Lecture and laboratory. I; 1 unit. Prerequisite: Bacteriology 104 or 300. CLARK, HALVORSON.

309. **Nutrition and Cultivation of Microorganisms.** Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, cultivation of bacteria, and microbiological assays. II; 1 unit. Prerequisite: Bacteriology 104 or 300; chemistry through quantitative analysis and organic. CLARK.

326. **Pathogenic Bacteriology.** A study of the pathogenic bacteria; classification, morphology, cultural requirements, and reactions; toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lecture and laboratory. I; 1 unit. Prerequisite: Bacteriology 104 or 300. WALLACE.

327. **Immunology and Serology.** A survey of the field of immunology; prevention of disease, diagnosis, and preparation and use of biologicals in the treatment of disease. Lecture and laboratory. II; 1 unit. Prerequisite: Bacteriology 104 or 300. WALLACE.

351. **Viruses.** The study of filtrable viruses as a branch of microbiology. Statistical, physical, and chemical properties of virus particles; analysis of host-virus, interaction; origin and natural relations of viruses. II; ¾ unit. Prerequisite: Bacteriology 300 or equivalent. LURIA.

IOLOGICAL SCIENCES

Through the Division of the Biological Sciences (including bacteriology, otany, entomology, physiology, psychology, zoology) it is possible to arrange a rogram leading to the degree of Master of Science in the Biological Sciences. tudents seeking admission to this division must have a grade-point average of .5 for that portion of the work which represents the last fifty per cent of the ours earned toward the bachelor's degree, exclusive of required physical educa- on and military training. No students on limited status will be admitted.

While the main emphasis is on botany and zoology, the candidate must have t least one unit in each of the following subjects: bacteriology, botany, ento- ology, physiology, and zoology. One unit in psychology (other than educational sychology) is strongly recommended. In planning his course of study the can- idate should give less emphasis to subjects in which he has already had consider- ble training. At least one unit must be taken in courses of graduate grade courses numbered 400 and above). No thesis is required, but at least one course ould be included in which individual problems are assigned. The Chairman of e Division of Biological Sciences is Professor F. B. Adamstone, 345 Natural istory Building.

Candidates for the degree of Master of Science in the Teaching of the Bio- gical Sciences and General Science must earn four units in biological sciences, wo units in education, and two units in electives. The two units in education ust include two of the following courses: Education 301, 302, 303, 304, one unit; nd Education 311 and 312, one unit. The courses in the biological sciences and e electives must be selected with the approval of the adviser. The electives may e in the biological sciences, in education, or, in exceptional cases, in other fields. course in biological chemistry and one in experimental psychology are strongly dvised. The adviser for candidates for this degree is Professor H. J. Fuller, 203 atural History Building.

Students wishing to combine training for research in biology with graduate ork in physics and chemistry may be interested in the curriculum offered under hysico-Chemical Biology (page 221).

OURSES FOR GRADUATES

72. **Advanced Cellular Physiology.** Same as Physiology 472. Architecture and dynamics of living material: molecular and microstructure of cells, cellular metabolism and energetics, enzyme kinetics, active transport, cellular movement, bioelectricity, effects of radiation, duplication. II; 1¼ units. Credit not allowed for both Physiology 362 and 472. Prerequisite: Physical chemistry and calculus. PROSSER.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

31. **Physico-Chemical Biology, Part I: Radiobiology.** Same as Botany 331 and Physiology 331. Action of ionizing radiations on living organisms. I or II; 1 unit. Prerequisite: One year of biology, physics, chemistry, and mathematics.

32. **Physico-Chemical Biology, Part II: Photobiology.** Same as Botany 332. Lecture and seminar course dealing with interaction of light and living matter (photosynthesis, phototropism, photoperiodism, vision, bioluminescence). I; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: One year of physics, chemistry, and biology; consent of instructor. RABINOWITCH.

33. **Physico-Chemical Biology, Part III: Electrobiology.** Same as Botany 333 and Physiology 333. Potentials produced by and effects of potentials upon living organisms. Lectures, student reports, and demonstrations. I, II; ¾ unit.

Offered in 1954-1955 and in alternate years. Prerequisite: Ten hours c biology; four hours of physical chemistry; ten hours of physics. PROSSER.

354. **Biophysics Laboratory.** Same as Physics 354. Laboratory experiments i optics, electricity, and nuclear physics designed to familiarize the studen with the physical apparatus and techniques useful in biophysics. II; 1 unit Prerequisite: General physics and calculus; consent of instructor. RAWCLIFFE

BOTANY

The Department of Botany offers graduate work leading to the Master o Science and Doctor of Philosophy degrees. Candidates for advanced degrees mus have had at least twenty hours of undergraduate work in botany, includin courses 130, 160, and 304 or 120; or fifteen hours in botany (including course 130, 160, and 304 or 120) and five hours in a related subject acceptable to th department. Graduate students who elect botany for minor credit must hav fifteen hours in botany or ten hours in botany and five hours in a related subjec acceptable to the department.

The following fields are available for specialization within the department plant morphology, plant physiology (including photosynthesis), systematic botany, mycology, plant pathology, plant ecology, plant geography, cytology genetics, cytogenetics, paleobotany, plant anatomy, and phycology.

Attention is called to courses in agronomy, bacteriology, chemistry, entomology, geography, geology, horticulture, mathematics, physics, physiology, plant pathology, and zoology, which are available for advanced students and offer a broad foundation for botanical work. Joint majors may be arranged in botany and agronomy, or botany and horticulture.

Admission to graduate work in the department is granted to graduates who meet the admission requirements of the Graduate College, which are described in the early sections of this catalog. Specifically, the applicant's undergraduate grade-point average for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of physical education and military training, must be at least 3.5. No one will be admitted with limited status.

Graduate students may avail themselves of the University Herbarium which contains some 350,000 specimens of vascular plants, bryophytes, fungi, and fossil plants. As outdoor laboratories, the University maintains two tracts of forest, Brownfield Woods and William Trelease Woods. In addition, certain areas of Robert Allerton Park near Monticello have been designated for research and advanced study. Several ranges of greenhouses are maintained for experimental work with living plant materials. Laboratories well equipped for research in plant physiology including exceptional facilities for studies of photosynthesis are available for students in these fields. Recently, new laboratories of cytogenetics and genetics, plant pathology (including a plant virus laboratory and greenhouses specially designed for research in virology), mycology, and paleobotany have been added and completely equipped. The maize Genetics Research Laboratory maintains an extensive collection of maize genetics stocks. In addition, it is making a systematic effort to discover and locate new genes, synthesize new linkage testers, construct more accurate linkage maps, etc. The College of Agriculture and the Agricultural Experiment Station offer unusual facilities to graduate students in the plant sciences. The Natural History Library with over 70,000 volumes offers excellent library facilities, with many bibliographical aids including the Gray Herbarium Card Index of American Plants, the Index to American Botanical Literature of the Torrey Botanical Club, and the Tilden Index Algarum Universalis. In addition, the University maintains such facilities as an electron micro-

scope, electron computer, betatron, ultra-centrifuge, and a radiocarbon laboratory for use in tracer studies.

Candidates for the master's degree in botany must take, in addition to the basic requirements listed above, one course in advanced morphology or systematic botany (Botany 320, 325, 345, 350, 360, or equivalent), one course in advanced physiology or ecology (Botany 335, 381, 385, 386, 388, 433, or equivalent), and Library Science 433. Candidates for the master's degree in botany must take an examination covering the field of general botany. This is primarily an oral examination, although, at the option of the faculty, it may include a written section. It is given during the latter part of the second semester of residence.

Candidates for the degree of Doctor of Philosophy in botany must take, in addition to the basic requirements listed above, the following courses (or they must be responsible for their content): one course in advanced systematic botany (Botany 360 or equivalent), one course in advanced morphology (Botany 320, 325, 350, or equivalent), one course in advanced physiology (Botany 335, 433, or equivalent), one course in ecology or plant geography (Botany 381, 385, 386, 388, or equivalent), one course in genetics (Botany 322 or equivalent), one course in mycology (Botany 372 or equivalent), and one course in plant anatomy (Botany 345 or equivalent). Under special circumstances a student may petition the Department of Botany to waive some of these requirements. All candidates for the Doctor of Philosophy degree in botany must pass a qualifying examination administered by the department. This examination is given during the latter part of the year which follows the award of the master's degree. It is an oral examination, but may include a written section. It covers the general field of botany including physiology, morphology, ecology, systematic botany, genetics, etc. The purposes of this examination are to determine the deficiencies of the student so that he may be advised to correct them, and to determine whether the student should be advised to continue his work for the Doctor of Philosophy degree.

Some time after the qualifying examination and the two foreign language examinations are passed the candidate is given a preliminary examination administered by a committee appointed by the Dean of the Graduate College. This examination is designed to test the candidate's knowledge of the fields of his major and minor subjects. A final examination administered by a committee appointed by the Dean of the Graduate College is given at least two weeks before the time when the degree is conferred. This examination is primarily on the student's research but need not be confined to this.

Master's and doctor's theses are due in the office of the Department of Botany ten days before they are due in the Graduate College office. During this period theses are available for reading by faculty members, who may suggest changes to be made in theses before they are delivered to the Dean of the Graduate College. Before writing their theses all graduate students are urged to obtain from the Graduate College office copies of "Instructions for Preparation of Theses."

Students are expected to secure a broad background in the whole field of botany, as well as in general biological principles. This may be achieved in part by courses, but an essential adjunct in the acquisition of this background is a program of reading and individual study. The following may be cited as examples of the type of subjects for private study: history of botany, philosophy of science (the student's attention is directed to Philosophy 328, a course in the philosophy of science, which may be taken or audited), and latest developments in the various branches of botany. In addition to courses required of all candidates, the student's adviser in a special branch of botany will recommend other courses to fit the student's special needs, both in his specialty and in allied subjects. Thus, the student in physiology will be advised to take certain courses in chemistry and physics, while a student in morphology or taxonomy may be instructed to

enroll in geology. Students are urged to prepare at least one research paper for publication before completing work for the doctor's degree.

Students desiring to obtain a master's degree preparatory to high school teaching should consider registration in the graduate teacher-training curriculum leading to the Master of Science degree in the Teaching of Biological Sciences and General Science (see page 59). The adviser for candidates for this degree is Professor H. J. Fuller, 203 Natural History Building.

Students who wish to major in plant pathology are referred to the section of this catalog devoted to plant pathology.

Students wishing to combine training for research in plant science or biology with graduate work in physics and chemistry may be interested in the curriculum offered under Physico-Chemical Biology (see page 221).

FELLOWSHIPS AND ASSISTANTSHIPS

A number of fellowships are available in the Graduate College. For a description of application procedures, stipends, and requirements, refer to the beginning section of the catalog. In addition, a number of teaching and research assistantships are available. Half-time assistantships provide a stipend of $1,350 for a two-semester year and carry exemption from the payment of tuition. Graduate students with half-time appointments spend twelve hours a week teaching in general botany or other laboratories and the remainder of their time is devoted to graduate study. Half-time research assistants are expected to work twenty hours a week and the remainder of their time is spent in graduate study. To obtain application blanks for either teaching or research assistantships, address the Chairman of the Department of Botany.

GRADUATE TEACHING FACULTY

Professors: O. Tippo (Chairman of Department), L. M. Black, R. Emerson, H. J. Fuller, G. N. Jones, E. I. Rabinowitch, M. M. Rhoades, L. Shanor, A. G. Vestal.
Associate Professors: J. F. Nance, W. N. Stewart.
Assistant Professor: P. C. Silva.
Instructor: J. A. Sacher.

COURSES FOR GRADUATES

402. **Physiological Genetics.** The probable nature of the gene and its action as deduced from studies on chromosome chemistry, genetically controlled reactions, cytoplasmic inheritance, mutation and gene analogues, with emphasis on higher plants and fungi. II; ½ or 1 unit. Prerequisite: Botany 322 or equivalent.

404. **Plant Virology.** Same as Horticulture 404 and Plant Pathology 404. Fundamental concepts; classification, symptomology; infectivity; biological, chemical, and physical properties; techniques for transmission, staining, assay, filtration, and purification; control methods; sources of information; history of virology. II; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Consent of instructor. Thornberry.

410. **Botanical Discussions.** Required of all graduate students in botany. I, II; 0 to ¼ unit.

411. **Discussions in Genetics and Cytogenetics.** Same as Zoology 411. I, II; ¼ unit. Kitzmiller, Luce, Rhoades.

413. **Discussions in Plant Physiology.** I; ¼ unit. Fuller, Nance.

414. **Discussions in Plant Morphology and Systematic Botany.** I, II; ¼ unit. Jones, Silva, Stewart.

417. **Discussions in Plant Pathology.** Same as Horticulture 417 and Plant Pathology 417. Required for majors in plant pathology and as elective for graduate students in plant science. I, II; ¼ unit. GOTTLIEB and STAFF.

418. **Discussions in Plant Ecology and Plant Geography.** Developments in ecology and plant geography, with emphasis on one special division. II; ¼ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Major in botany, entomology, geography, or zoology. VESTAL.

419. **Discussion in Photosynthesis and Related Topics.** I, II; ¼ unit. Prerequisite: Consent of instructor. EMERSON, RABINOWITCH.

420. **Cytogenetics.** An advanced course in which emphasis is placed on the correlation of genetic data with chromosomal aberrations. I; 1 unit. Prerequisite: Botany 320 and 322, or equivalent. RHOADES.

427. **Discussions in Mycology.** A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. I, II; ¼ unit. Prerequisite: Consent of instructor. SHANOR.

433. **Advanced Physiology of Growth, Responses, and Reproduction.** I; 1 unit. Prerequisite: Botany 130 or equivalent. FULLER.

471. **Advanced Mycology — Special Groups.** Special groups of fungi and their activities are considered. Different groups for concentrated study may be selected each semester depending upon the student's interest in mycology. I, II; ½ unit. Prerequisite: Consent of instructor. SHANOR.

472. **Industrial Mycology.** The characteristics, relationships, and activities of fungi of industrial importance are considered. Yeasts and mushrooms are included but major emphasis is placed on Mucorales, Aspergilli, Penicillia, and Fungi Imperfecti. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Consent of instructor. SHANOR.

493. **Research.** I, II; ½ to 4 units. Work may be taken in the following fields, subject to approval of one of the staff:
(a) **Plant Morphology.** SILVA, STEWART, TIPPO.
(b) **Plant Physiology.** FULLER, NANCE.
(c) **Taxonomy of Vascular Plants and Bryophytes.** JONES.
(d) **Mycology.** SHANOR.
(e) **Plant Pathology.** BLACK and Plant Pathology Staff.
(f) **Plant Ecology or Plant Geography.** VESTAL.
(g) **Plant Anatomy.** SACHER, TIPPO.
(h) **Photosynthesis.** EMERSON, RABINOWITCH.
(i) **Genetics and Cytogenetics.** RHOADES.
(j) **Paleobotany.** STEWART.
(k) **Phycology.** SILVA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Individual Topics.** For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Undergraduates may not offer more than five hours in Botany 300 toward a bachelor's degree, nor graduate students more than one unit in Botany 300 toward a master's degree. I, II; ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. STAFF.

304. **General Plant Morphology.** A survey of the principles of plant morphology as exemplified by the various plant groups. Modification of the course will be made to meet the needs of teachers and prospective teachers during the summer. I; ½ or 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132. STEWART.

306. **Biology for Teachers.** Same as Zoology 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. Note: In order to make possible out-of-town practice teaching, this course will be completed during the first six weeks of the semester. II; ¼ or ½ unit. Prerequisite: Botany 100 and Zoology 101 or 104, or a one-year course in general biology. FULLER, MATTESON.

307. **Fruit Diseases.** Same as Horticulture 307 and Plant Pathology 307. Symptomatology; laboratory and field studies of representative diseases; control measures. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Botany 317 or 372. POWELL.

308. **Vegetable and Canning Crop Diseases.** Same as Horticulture 308 and Plant Pathology 308. Symptomatology; laboratory and field studies of representative diseases; control measures. II; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Botany 317 or 372. LINN.

317. **Plant Pathology.** Same as Agronomy 317, Horticulture 317, and Plant Pathology 317. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science including Botany 100. BLACK.

320. **Cytology.** Study of nuclear and cell division with emphasis on chromosome structure and behavior. Various aspects of cytological behavior are considered in relation to genetics and development. II; 1 unit. Prerequisite: One year of botany. RHOADES.

322. **Genetics.** A basic treatment of the facts and fundamental principles of genetics, with special emphasis on plants. I; 1 unit. Prerequisite: One year of botany.

325. **Paleobotany.** Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. II; ½ or 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Botany 100 or Division of General Studies 131 and 132; Geology 101 or consent of instructor. STEWART.

331. **Physico-Chemical Biology, Part I: Radiobiology.** Same as Biological Sciences 331 and Physiology 331. Action of ionizing radiations on living organisms. I or II; 1 unit. Prerequisite: One year of biology, physics, chemistry, and mathematics. QUASTLER.

332. **Physico-Chemical Biology, Part II: Photobiology.** Same as Biological Sciences 332. Lecture and seminar course dealing with interaction of light and living matter (photosynthesis, phototropism, photoperiodism, vision, bioluminescence). I; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: One year of physics, chemistry, and biology; consent of instructor. RABINOWITCH.

333. **Physico-Chemical Biology, Part III: Electrobiology.** Same as Biological Sciences 333 and Physiology 333. Potentials produced by and effects of potentials upon living organisms. Lectures, student reports, and demonstrations. I or II; ¾ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Ten hours of biology; four hours of physical chemistry; ten hours of physics. PROSSER.

335. **Plant Physiology: Metabolic Transformations.** II; ½ or 1 unit. Prerequisite: One year of botany, including Botany 130; one year of chemistry. NANCE.

340. **Histological Technic.** Survey of technics used in the preparation of plant tissues for microscopical examination. II; ½ or 1 unit. Prerequisite: One year of botany or ten hours of zoology. SACHER.

345. **Plant Anatomy.** Study of the internal structure of vascular plants with special emphasis on development, function, and evolutionary history. I; ½ or 1 unit. Prerequisite: One year of botany. SACHER.

350. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology of algae. II; ½ or 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. SILVA.

360. **Advanced Systematic Botany.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. I; ½ or 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Botany 160. JONES.

366. **Field Botany.** Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. JONES.

372. **General Mycology.** Structure, classification, and identification of fungi, including those of economic importance. Modification of the course will be made to meet the needs of teachers and prospective teachers during the summer. II; 1 unit. Prerequisite: One year of botany, bacteriology, entomology, or zoology. SHANOR.

377. **Diseases of Field Crops.** Same as Agronomy 377 and Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Botany 317 or consent of instructor. BEVER, GERDEMANN.

379. **Research Methods in Plant Pathology.** Same as Agronomy 379, Horticulture 379, and Plant Pathology 379. Lectures and laboratory techniques for isolation, for culture of and inoculation with plant pathogens, for the evaluation of plant protectants; for the study of the physiology of parasitism and methods of evaluation of data and preparation of manuscripts. I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Botany 317. GERDEMANN, GOTTLIEB.

381. **Plant Ecology.** Principles of ecology, exemplified by vegetation and environments of Illinois. I; ½ unit. Prerequisite: One year of botany. VESTAL.

385. **Plant Geography of North America.** Vegetation regions and principal subdivisions; environments, plant cover, floras. I; ½ or 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: One year of botany. VESTAL.

386. **Plant Geography of Continents Other Than North America.** Regions, vegetation-types, notable species. I; ½ or 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: One year of botany. VESTAL.

388. **Ecology: Plant Communities.** Characteristics, types, development, and classification of communities. II; ½ or 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: One year of botany, including Botany 280 or 381. VESTAL.

BUSINESS

The degree of Doctor of Philosophy in Business is awarded to those who complete the subject-matter requirements listed below and the general requirements named in the forepart of this catalog. The subject-matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institu-

tion offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Students lacking adequate preparation for admission may be admitted with the consent of the adviser or committee in charge, but must remove any deficiencies during the first year of residence by taking prescribed courses without credit toward the advanced degree. Those candidates who hold a master's degree in economics or business can usually complete the requirements in two years by appropriate synchronization of courses previously taken with those offered in this program.

In lieu of the provisions on major and minor subjects on page 22, candidates for the Doctor of Philosophy degree in Business will prepare themselves for examination in five fields including management, marketing, and economic theory. At least two other fields must be selected, one of which (two units) may be outside the College of Commerce and Business Administration if approved by the adviser. For numbers and titles of courses available, see the courses listed in this catalog under Accountancy, Economics, Management, and Marketing.

Inasmuch as the major fields for this degree cross departmental lines, administration of the work is in the hands of a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the Chairman of the Committee on the Doctor of Philosophy Degree in Business, 214 David Kinley Hall, Urbana, Illinois.

BUSINESS EDUCATION

The Department of Business Education offers graduate work leading to the degree of Master of Science in Commercial Teaching. The work is part of an integrated five-year program for those preparing to become commercial teachers. The detailed requirements of the four-year curriculum are given in the bulletin on Undergraduate Study. The requirements of the fifth year are based on the educational background of the first four years. Students may also take advanced degree programs in education specializing in business education.

Students seeking admission in any area must have a grade-point average of 3.5 for that portion of the work which represents the last fifty per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training. Students on limited status will not be admitted. Only a limited number of the requirements listed below may be completed by extramural graduate study. Questions related to extramural courses should be referred to the appropriate graduate adviser.

Candidates for the degree of Master of Science in Commercial Teaching must earn three units in education, consisting of the courses listed in Group 1 below; three units in commerce, consisting of two units from courses listed in Group 2 below and one unit from courses listed in Group 3 below (business education); and two units of electives. All courses must be selected with the approval of the student's adviser.

(1) Education. Three units consisting of Education 311, 312, 456, and two of the following: Education 301, 302, 303, 304.

(2) Commerce (other than business education). Two units selected from Accountancy 308, 371, 401, 427; Business Law 301; Economics 312, 326, 328, 378, 384, 388, 400, 414, 415, 436, 440, 441; Management 312; Marketing 315, 372, 373, 387, 401, 415, 421, 481.

(3) Commerce (business education). One unit selected from Business Education 351, 352, 353, 361, 382, 383, 491.

(4) Recommended Electives. Two units selected from courses listed under (1) and (2), or not more than one unit from (3), or from courses in the fol-

owing list: Education 354, 381, 390, 391, 401, 411, 413, 422, 423, 425, 428, 439, 460; Journalism 308; Rhetoric 351. These courses are suggestions only; others may be taken with the consent of the adviser.

The adviser for candidates for this degree is Professor Arnold C. Condon, 2 David Kinley Hall.

ASSISTANTSHIPS

Teaching assistantships are occasionally available for highly recommended candidates for any of the graduate degrees ordinarily taken by business teachers. For information write the Head of the Department.

GRADUATE TEACHING FACULTY

Associate Professor: A. C. Condon (Head of Department).
Assistant Professor: Elizabeth R. Melson.

COURSES FOR GRADUATES

491. **Thesis.** I, II; ½ to 2 units. Condon.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. **Improvement of Instruction in Shorthand.** A study of the history, principles, and practices of shorthand instruction, including evaluation of literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce including Business Education 112; sixteen hours in education including Education 242. Condon.

352. **Improvement of Instruction in Typewriting.** A study of the history, principles, and practices of typewriting instruction, including evaluation of literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce including Business Education 203; sixteen hours in education including Education 242. Melson.

353. **Improvement of Instruction in Bookkeeping.** A study of the history, principles and practices of bookkeeping instruction, including evaluation of literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce including six hours in accountancy; sixteen hours in education including Education 242. Staff.

361. **Teaching Office Management and Machine Operations.** Designed for high school and college teachers. Selection and use of machines, course content for machine courses, and organization of instructional material. S; ½ unit. Prerequisite: Education 241, 242; sixteen hours in commerce, six of which must be in accountancy; one year of teaching experience. Melson.

382. **Organization and Administration of Cooperative Part-time Programs in Business Education.** Deals with background, aims, coordination techniques, and administrative policies for organizing and operating cooperative part-time programs in distributive and office occupations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce; consent of instructor.

383. **Problems in Cooperative Education.** Students apply for and secure distributive or office positions with selected cooperating business firms. While regularly employed in these supervised positions, they observe the relationships

between those activities and the cooperative business education programs in the high school. These relationships are pointed up through regularly scheduled class meetings where emphasis is placed on job analysis, current trends, wage and benefit structure, personnel practices, and labor relations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce.

BUSINESS LAW

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE TEACHING FACULTY

Professors: E. R. Dillavou (Head of Department), P. C. Roberts.
Assistant Professor: W. O. Morris.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Business Torts.** Liability of businessmen for their wrongful acts, and those of their agents arising separate and apart from their liabilities under contracts; covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, inducing breach of contract. II; ¾ to 1 unit. Prerequisite: Business Law 201, 202, 100, or 261. Morris.

301. **The Law of Security Transactions and Banking.** Significant phases of law in the fields of pledges, chattel mortages, conditional sales, suretyship, insurance, real property, banks and banking, and bankruptcy. Under real property, real estate mortgages, landlord and tenant and mechanics liens are considered as well as the general principles of real property. I, II; ½ to 1 unit. Prerequisite: Credit or registration in Business Law 202. Dillavou.

302. **Wills, Estates, and Trusts.** A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. I; ½ to 1 unit. Prerequisite: Business Law 201 and 202. Roberts.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers graduate work leading to the degrees of Master of Science in Ceramics, Master of Science in Ceramic Engineering, Doctor of Philosophy in Ceramics, and Doctor of Philosophy in Engineering.

The prerequisite for a major in graduate work in ceramics or ceramic engineering is proficiency in the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired, or substantial equivalents. An applicant's undergraduate grade-point average must be at least 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. No student will be admitted on limited status.

Candidates for the degree of Doctor of Philosophy in Ceramics must have had the equivalent of at least twenty-five semester hours of satisfactory courses in general, analytical, physical, and organic chemistry; also calculus, one year of college physics, and at least eighteen semester hours or their equivalent in acceptable ceramic courses.

Students with bachelor's degrees in chemistry, physics, or engineering may

become candidates for the Master of Science or Doctor of Philosophy degrees but must make up deficiencies in ceramics by taking undergraduate courses at reduced graduate credit. The student must, however, always be registered in at least one unit of graduate work.

The fields for majoring in ceramics or ceramic engineering are refractories, porcelain enamels, glass, whitewares, structural clay products, and materials. The most common minors selected by graduate students in ceramic engineering are chemistry, physics, metallurgy, mathematics, geology, and engineering. A first minor may, however, be taken in the Department of Ceramic Engineering.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramic prerequisite.

FELLOWSHIPS

The following Graduate College fellowships are offered by the Department of Ceramic Engineering: Ferro Corporation Fellowship; Edward Orton, Jr. Fellowship; Owens-Illinois Fellowship; Titanium Alloy Division of National Lead Company Fellowship.

GRADUATE TEACHING FACULTY

Professors: A. I. Andrews (Head of Department), R. L. Cook, F. V. Tooley.

Associate Professor: A. W. Allen.

COURSES FOR GRADUATES

401. **Ceramic Chemistry.** Silica, silicates, fusions, and phase relations. I; 1 unit. Prerequisite: Courses in chemistry and physics. Andrews.

402. **Ceramics.** Chemical and physical phenomena. II; 1 to 2 units. Prerequisite: Courses in physics and chemistry. Andrews.

403. **Drying.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 203 or equivalent.

404. **Firing.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 204 or equivalent.

405. **Glass Technology.** This course, designed for ceramic engineering graduates, is required for students majoring in glass technology, and may be elected by students majoring in some other branch of ceramic engineering. The course is concerned with the study of the properties of glass of importance in manufacturing and end use; emphasis is placed equally on research, control, development, and production aspects of the subject. I; 1 unit. Prerequisite: Ceramic Engineering 214 and 217, or equivalent. Tooley.

406. **Glass Technology.** This course, designed for ceramic engineering graduates, is required for students majoring in glass technology and may be elected by students majoring in some other branch of ceramic engineering. The course, a continuation of Ceramic Engineering 405, completes the formal study of glass by taking up lesser known properties of importance in manufacture and end use. The course includes comprehensive literature surveys on selected topics and seminar type reports on classical researches in glass technology. Emphasis tends to the research point of view. II; 1 unit. Prerequisite: Ceramic Engineering 405. Tooley.

407. **Porcelain Enamels.** Advanced study in the composition, properties, and processing of porcelain enamels. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 222 and 223, or equivalent. Andrews.

408. **Refractories.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 218 or equivalent. Allen.

409. **Special Ceramic Bodies and Glazes.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 211 or equivalent. Cook.

491. **Thesis.** Research in any of the branches of ceramics. I; 1 to 4 units. Allen, Andrews, Cook, Tooley.

492. **Thesis.** Research in any of the branches of ceramics. II; 1 to 4 units. Allen, Andrews, Cook, Tooley.

495. **Materials and Special Problems.** Conference and laboratory. I or II; 1 to 2 units. Allen, Andrews, Cook, Tooley.

CHEMISTRY AND CHEMICAL ENGINEERING

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or Chemical Engineering.

Students who have fulfilled the undergraduate course requirements as specified below may apply for entrance to the Graduate College in chemistry or chemical engineering if they have a grade-point average of 4.0 for that portion of undergraduate work representing the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of hygiene, military, and physical education courses. Students will not be admitted on limited status.

Students who have completed graduate work in chemistry or chemical engineering and related subjects at another institution may be admitted provided (1) their undergraduate records meet the above requirements, and (2) their grade-point averages in graduate work are at least 4.0. Students whose undergraduate records have not met the above requirements must have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution in order to be admitted to the Graduate College in chemistry and chemical engineering.

All students who receive permits to enter the Graduate College in chemistry or chemical engineering, regardless of whether they have had training beyond the bachelor's degree, must take registration examinations. These are offered in the week prior to the opening of the first semester for those entering in the fall, in the week prior to the opening of the second semester for those entering in February, and in the week prior to the opening of the summer session for those entering at that time. Those who intend to major in any field of chemistry must take four examinations covering the normal undergraduate instruction in inorganic, analytical, organic, and physical chemistry; those who intend to specialize in chemical engineering must take two of the examinations in chemistry, one of which must be physical chemistry and the other of the student's own selection; and, in addition, two in chemical engineering covering the usual undergraduate instruction in that subject. The results of these registration examinations are not permanently recorded but serve merely to assist in the registration of students in the proper graduate courses. Students who demonstrate through these examinations that they are deficient will be required to register in one or more specific courses before taking more advanced work in a particular field. Most of these courses allow graduate residence credit. Students who have received permits to enter the Graduate College in chemistry or chemical engineering should contact the department immediately to learn the dates when these registration examinations will be given and to obtain any other detailed information desired.

Students who are candidates for admission to the Graduate College in chemistry or chemical engineering must have had the equivalent of twenty-five semester hours in chemistry properly distributed.

Students who intend to take graduate work for an advanced degree in chem-

istry or chemical engineering should include in their undergraduate preparation at least the equivalent of one full year of physics, one year of French, one year of German, and mathematics through differential and integral calculus. Any student without the necessary physics or mathematics may enter the Graduate College but will be required to spend part of his time in residence to remove the deficiency.

A language is not required for students entering the Graduate College in chemical engineering. In order to be admitted as a candidate for an advanced degree in chemistry a student must have had one year of college French or German (preferably German). Where the applicant has done two or three years of work in French or German in secondary school, the requirement will be considered to be met, provided at least one semester of the language more advanced than his secondary school work has been done in college. Four years of French or German completed in a secondary school will be accepted in lieu of any college work in the subject. An applicant who has a knowledge of French or German, but who lacks formal credentials, may be examined to determine his language status. Such an applicant should correspond with the Director of Admissions and Records with reference to his examination.

In meeting the language requirements for the degree of Doctor of Philosophy in Chemistry or Chemical Engineering, a student may substitute Russian for French on the direct recommendation of the Department of Chemistry and Chemical Engineering (and without formal petition), provided such recommendation is approved by the Dean of the Graduate College.

Candidates for the Master of Arts or Master of Science degree with a major in chemistry or chemical engineering must include among their courses Chemistry 240 and 241, or the equivalent.

Candidates for the Doctor of Philosophy degree in any branch of chemistry or chemical engineering must include among their courses Chemistry 240, 241, 342, and 343, or the equivalent. They will also be required to take Chemistry 494 unless they include in their graduate program at least two units of "400" courses in physical chemistry, excluding Chemistry 440.

Before taking chemistry or chemical engineering courses for graduate credit, graduate students whose major subject is in some department other than chemistry and chemical engineering must have had the equivalent of fifteen semester hours in chemistry, including satisfactory work in general chemistry, qualitative and quantitative analysis, and elementary organic chemistry. Such students are advised to make selections from the following courses: Chemistry 240, 241, 315, 316, 327, 329, 336, 337, 342, 343, and 350. Courses of a more special nature will not, as a rule, be accepted for graduate work unless preceded by one or more of the above courses.

Students majoring in other departments who desire a sole minor in chemistry or chemical engineering toward the Doctor of Philosophy degree must include in their program Chemistry 240, 241, 342, 343, or must receive from the Head of the Physical Chemistry Division of the department a written statement that similar courses taken at other institutions are the equivalent.

Students majoring in other departments who desire a first minor in chemistry or chemical engineering toward the Doctor of Philosophy degree must include in their program Chemistry 240 and 241, or must receive from the Head of the Physical Chemistry Division of the department a written statement that similar courses taken at other institutions are the equivalent.

Graduate students in departments other than chemistry and chemical engineering will be allowed graduate credit for Chemistry 240 and 241.

Candidates for the degree of Master of Science in the Teaching of Chemistry must earn four units in chemistry, two units in education, and two units in electives. The two units in education must include two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit.

The courses in chemistry and the electives must be selected with the approval of the adviser. The electives may be in chemistry, in education, or, in exceptional cases, in other fields. For admission to this program the student must have the grade-point average required by the department, and no limited status students will be admitted. The adviser for candidates for this degree is Professor J. C. Bailar, Jr., 107 Chemistry Annex.

For work in physical sciences, see page 220.

FELLOWSHIPS AND ASSISTANTSHIPS

The Graduate College offers fellowships to worthy students including those who intend to specialize in chemistry or chemical engineering. Applications should be sent to the Dean of the Graduate College. In addition, the Department of Chemistry and Chemical Engineering has industrial or institutional fellowships and research assistantships for chemistry and chemical engineering students which vary in number from year to year. These appointments are awarded upon application, more often to those students who have already been at the University of Illinois for two semesters and who have demonstrated their ability in the Graduate College. The department also has several postdoctoral research assistantships available. Applications for research assistantships should be sent directly to the Department of Chemistry and Chemical Engineering.

Teaching assistantships in chemistry and chemical engineering are numerous. These are open to all students who are entering for graduate study. Applications for teaching appointments should be made directly to the Department of Chemistry and Chemical Engineering.

GRADUATE TEACHING FACULTY

Professors: H. E. Carter (Head of Department), R. Adams, L. F. Audrieth, J. C. Bailar, Jr., A. M. Buswell, G. L. Clark, H. G. Drickamer, D. T. Englis, R. C. Fuson, H. F. Johnstone, H. A. Laitinen, N. J. Leonard, C. S. Marvel, G. T. Moeller, T. E. Phipps, W. H. Rodebush, W. C. Rose, G. F. Smith, H. R. Snyder, F. T. Wall.

Associate Professors: D. Y. Curtin, R. B. Duffield, L. E. Miller, R. F. Nystrom, B. R. Ray, C. S. Vestling.

Assistant Professors: Virginia Bartow, E. J. Corey, R. K. Finn, H. S. Gutowsky, T. J. Hanratty, L. M. Henderson, R. A. Johnson, J. Larner, M. S. Peters, J. W. Westwater, P. E. Yankwich.

Instructors: E. Alperovitch, M. Jones, H. V. Malmstadt, W. L. Masterton.

COURSES FOR GRADUATES

402. **Inorganic Chemistry.** The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. I, II; ¾ unit. Moeller.

404. **Inorganic Chemistry.** Advanced laboratory. Inorganic preparations and qualitative analysis involving the less familiar elements. I, II; ¼ to ¾ unit. Prerequisite: Credit or registration in Chemistry 402. Audrieth.

405. **Inorganic Chemistry.** Seminar. Required of all graduate students whose major is inorganic chemistry. I, II; ¼ unit. Audrieth.

406. **Special Topics in Inorganic Chemistry.** Discussions and reports. II; ¾ unit. Bailar.

421. **Spectrochemical Methods of Analysis.** Lectures and laboratory. Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry,

interferometry, and polarimetry. I; ¾ unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree. MALMSTADT.

422. **Electrical Methods of Chemical Analysis.** Lectures and laboratory. Polarography, potentiometric, amperometric, conductometric titrations, dielectric methods, etc. II; ¾ unit. LAITINEN.

423. **Microanalysis.** Advanced principles, techniques, and applications; qualitative and quantitative inorganic and quantitative organic methods. I; ¾ unit. Prerequisite: Chemistry 110 and 124, or equivalent; Chemistry 336 or equivalent. JOHNSON.

424. **Quantitative Analysis.** Advanced principles, including chemical statistics, calculations, experimental methods, and applications. II; ½ unit. SMITH.

425. **Analytical Chemistry.** Seminar. Special topics in analytical chemistry. Required of all graduate students whose major or minor is analytical chemistry. I, II; ¼ to 1 unit. CLARK.

426. **Applied X-rays.** Lectures. I; ¾ unit. Prerequisite: Training in physics and physical chemistry. CLARK.

427. **Applied X-rays (Crystallography).** Lectures. II; ¾ unit. Prerequisite: Training in physics and physical chemistry. CLARK.

428. **Applied X-rays.** Laboratory. Optional laboratory work to accompany lectures in Chemistry 426 and 427. Training in operation of all types of X-ray apparatus with special emphasis on diffraction; experimental chemical identification and crystal structure analyses from powder and single crystal patterns. I; ½ unit. Prerequisite: Chemistry 426 or 427; training in physics, mathematics, and physical chemistry. CLARK.

429. **Applied X-rays.** Laboratory. Optional laboratory work to accompany lectures in Chemistry 426 and 427. Training in operation of all types of X-ray apparatus with special emphasis on diffraction; experimental chemical identification and crystal structure analyses from powder and single crystal patterns. II; ½ unit. Prerequisite: Chemistry 426 or 427; training in physics, mathematics, and physical chemistry. CLARK.

430. **Organic Chemistry.** Survey of organic chemistry designed for first-year graduate students. I, II; 1 unit. Prerequisite: One year (ten hours) of organic chemistry. FUSON, SNYDER.

432. **Organic Chemistry.** Advanced survey of organic chemistry (to follow Chemistry 430). II; 1 unit. Prerequisite: Chemistry 430 or equivalent. LEONARD.

433. **Organic Chemistry.** Optical isomerism, *cis-trans* isomerism, tautomerism, chemistry of the carbohydrates, etc. I; ¾ unit. Prerequisite: Chemistry 430 and 432, or consent of instructor. CURTIN.

434. **Advanced Organic Synthesis.** I, II; ½ to 1 unit. LEONARD, MILLER.

435. **Organic Chemistry.** Seminar. Current literature in organic chemistry. I, II; ½ unit. Prerequisite: Consent of instructor. In most cases, students must be doing research in organic chemistry and be registered for the degree of Doctor of Philosophy. ADAMS.

436. **Organic Chemistry.** Quantitative organic analysis and newer methods in organic laboratory procedure. A laboratory course designed to acquaint students with newer research techniques. I, II; ½ to 1 unit. COREY.

440. **Physical Chemistry.** Survey of physical chemistry for graduate students. I, II; 1 unit. Prerequisite: Chemistry 240 and 342, or equivalent. PHIPPS, WALL.

441. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and calculation of thermodynamic quantities. I; 1 unit. Prerequisite: Elementary physical chemistry. WALL.

442. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and calculation of thermodynamic quantities. II; 1 unit. Prerequisite: Elementary physical chemistry. WALL.

443. **Molecular Structure.** The structure of molecules and relationships to physical properties. II; 1 unit. Prerequisite: Chemistry 342. YANKWICH.

444. **Physical Chemistry.** Kinetic theory in statistical mechanics. I or II; ¾ unit. Offered in 1954-1955 and in alternate years, alternating with Chemistry 446. Prerequisite: Chemistry 441 and 442. PHIPPS.

445. **Physical Chemistry.** Seminar. I, II; ¼ to ½ unit. Prerequisite: Consent of instructor. WALL.

446. **Quantum Chemistry I.** Introduction to quantum mechanics and its application to chemical problems. Lectures. I; ¾ unit. Offered in 1955-1956 and in alternate years, alternating with Chemistry 444. Prerequisite: Chemistry 443; consent of instructor. GUTOWSKY.

447. **Quantum Chemistry II.** A continuation of Chemistry 446; primarily the application of quantum theory of molecular structure and molecular spectra. Lectures. II; ¾ unit. Offered in 1955-1956 and in alternate years, alternating with Chemistry 448. Prerequisite: Chemistry 446. GUTOWSKY.

448. **Chemical Kinetics.** Chemical reaction and the theory of rate processes. Lectures. II; ¾ unit. Offered in 1954-1955 and in alternate years, alternating with Chemistry 447. Prerequisite: Chemistry 444 or equivalent; consent of instructor. GUTOWSKY.

450. **Biochemistry.** Lectures and readings. Chemistry of intermediary metabolism. II; ¾ unit. Prerequisite: Chemistry 350 and 355, or equivalent. CARTER.

452. **Advanced Techniques in Biochemistry.** Difficult biochemical preparations; analytical methods made use of in biochemical research. I, II; ½ to 1 unit. Prerequisite: Chemistry 350 and 355. HENDERSON.

455. **Biochemistry.** Seminar. Current literature. Required of all graduate students whose major is biochemistry. I, II; ¾ unit. Prerequisite: Chemistry 350 and 355, or equivalent. CARTER.

485. **Chemistry of Water Treatment.** Seminar. Special problems and new developments in sanitary chemistry. I, II; ¼ to 1¼ units. Prerequisite: Graduate standing in science or engineering. BUSWELL.

490. **Research.** Candidates for the Master of Arts or Master of Science degree who elect research are required to present a thesis. A thesis is always required of students working toward the degree of Doctor of Philosophy. Not all candidates for thesis work necessarily will be accepted. Students whose major is in departments other than chemistry must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. I, II; ¼ to 4 units. Work may be taken in the following fields, subject to the approval of one of the qualified staff members.

Analytical Chemistry (including X-rays, Electron Microscopy, Polarography, Food and Plant Chemistry). CLARK, ENGLIS, JOHNSON, LAITINEN, MALMSTADT, G. F. SMITH.

Biochemistry. CARTER, HENDERSON, LARNER, ROSE, VESTLING.

Inorganic Chemistry. AUDRIETH, BAILAR, MOELLER.

Organic Chemistry. ADAMS, COREY, CURTIN, FUSON, LEONARD, MARVEL, MILLER, SNYDER, TAYLOR.

Physical Chemistry (including Radiochemistry). DUFFIELD, GUTOWSKY, PHIPPS, RAY, RODEBUSH, WALL, YANKWICH.

Chemistry:

Water Chemistry. Buswell.

Applied Electrochemistry (Organic and Inorganic). Swann.

Radiocarbon Chemistry. Nystrom.

Students who intend to major in chemistry in one of these special fields should consult with the professor in charge of the thesis and with the Head of the Department of Chemistry and Chemical Engineering in regard to the program of courses and examinations.

492. **Chemical Literature and Reference Work.** I; ¼ unit. Bartow.

494. **Selected Topics in Chemical Principles.** A course for graduate students in chemistry who do not plan to take two or more units of "400" courses in physical chemistry (except Chemistry 440). The topics include various aspects of molecular spectra, thermodynamics, electrochemistry, and chemical kinetics. II; ¾ unit. Prerequisite: Chemistry 342 and 343 with consent of department, or Chemistry 440.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

515. **Inorganic Chemistry.** Nuclear and extranuclear atomic structures and their relation to the properties of the elements and of their compounds; types of bonding; survey of the periodic relationships, preparation, and applications of the elements and their compounds. I, II; ¾ unit. Prerequisite: Fifteen hours of credit in chemistry courses exclusive of courses numbered below 110. Audrieth.

516. **Inorganic Chemistry.** Preparation of typical inorganic compounds illustrating special and more advanced techniques. I, II; ½ unit. Prerequisite: Credit or registration in Chemistry 315. Audrieth.

524. **Introductory Microanalysis and Microscopy.** Lectures and laboratory. II; ¾ unit. Prerequisite: Chemistry 124 or equivalent. Johnson.

525. **Analytical Chemistry.** A survey course for advanced undergraduate and graduate students requiring further training and review in analytical chemistry. II; ¾ unit. Laitinen.

526. **Chemical Analysis and Treatment of Water.** Chemical and instrumental methods for analysis of water and determination of quality; chemical principles and processes in water purification and conditioning; relationship of chemistry of water to municipal and industrial use. I; ¾ unit. Prerequisite: Chemistry 124. Englis.

527. **Special and Instrumental Methods of Analysis.** Electrical and optical methods, and other advanced analysis. I, II; ¾ unit. Prerequisite: Chemistry 124, 234, 240, and 241; or consent of instructor. Malmstadt.

529. **Food Analysis.** Quantitative organic analysis of food products; alcohols, carbohydrates, fats and oils, cereals, nitrogenous bodies, preservatives, and colors. II; 1¼ units. Prerequisite: Chemistry 122 or 124, and 133 or 234. Englis.

533. **Applied Electrochemistry.** Lectures. Use of electric current through solutions for carrying out reactions. Open to students in the curriculum in chemistry and chemical engineering. Prerequisite: Chemistry 234, 336, and 342. II; ½ unit. Swann.

536. **Organic Chemistry.** Second course. Lectures and recitations. I, II; ¾ unit. Prerequisite: Chemistry 124 and 234. Corey, Marvel.

537. **Organic Chemistry.** Laboratory experiments in organic chemistry. I, II; ½ unit. Prerequisite: Chemistry 234; credit or registration in Chemistry 336. Corey, Taylor.

338. **Systematic Identification of Organic Compounds.** I, II; ¾ unit. Prerequisite: Chemistry 336 and 337, or equivalent. FUSON, SNYDER.

342. **Elementary Physical Chemistry.** Lectures. I, II; ¾ unit. Prerequisite: Chemistry 240. GUTOWSKY, PHIPPS.

343. **Elementary Physical Chemistry.** Laboratory to accompany Chemistry 342. I, II; ¼ unit. Prerequisite: Chemistry 240 and 241; credit or registration in Chemistry 342. GUTOWSKY, YANKWICH.

344. **Principles of Chemical Thermodynamics.** Thermodynamics and free energy calculations. I, II; ¾ unit. Prerequisite: Chemistry 240 and 342, or consent of instructor. PHIPPS, RODEBUSH.

345. **Colloid and Surface Chemistry.** Physical chemistry of colloid systems; properties of surfaces and inter-faces; applications. I; ¾ unit. Prerequisite: Chemistry 342 or consent of instructor. RAY.

346. **Atomic Structure and Valence.** Advanced physical chemistry. I; ½ unit. Prerequisite: Chemistry 240 and 342. YANKWICH.

347. **Elementary Physical Chemistry.** A one-semester course in chemical principles with emphasis on topics and applications most important to students in agriculture, the biological sciences, and pre-medicine, and to graduate students needing a brief foundation course. Not open to students in chemistry or engineering curricula. Lectures, problems, and laboratory. I; ¾ unit. Prerequisite: Physics 102 or 104, Chemistry 122 and 133, or equivalent. RAY.

349. **Colloid and Surface Chemistry.** Laboratory. Quantitative experiments in colloid and surface chemistry. I, II; ¼ unit. Prerequisite: Credit or registration in Chemistry 345 or 249, or consent of instructor. RAY.

350. **Biochemistry.** Chemistry of carbohydrates, lipids, and proteins; the alimentary processes, blood, tissues, and metabolism. Clinical aspects for prospective students of medicine. Lectures and assigned readings. I, II; ¾ unit. Prerequisite: Chemistry 122 or 124, and 133 or 234; registration in Chemistry 355 or 354. CARTER, ROSE.

351. **Techniques of Blood Analysis and Their Applications.** II; ¾ unit. Prerequisite: Chemistry 350 and 355. LARNER.

352. **Biochemistry of Vitamins and Hormones.** II; ¾ unit. Prerequisite: Chemistry 350 and 355. HENDERSON.

354. **Biochemistry Laboratory.** Experiments on the chemistry of carbohydrates, lipids, and proteins; the alimentary processes, blood, tissues, and metabolism; laboratory quizzes and assigned readings. A less extensive course for those who are unable to devote the time necessary to take Chemistry 355. This course does not meet the requirements for registration in advanced courses in biochemistry. I, II; ½ unit. Prerequisite: Chemistry 122 or 124, and 133 or 234; registration in Chemistry 350. VESTLING.

355. **Biochemistry Laboratory.** Required of all students who expect to take advanced courses in biochemistry. Experiments on the chemistry of foodstuffs, digestion, blood and tissue composition, and metabolism; quantitative analysis of gastric contents, blood, and urine; laboratory quizzes and assigned readings. I, II; ¾ unit. Prerequisite: Chemistry 122 or 124, and 133 or 234; registration in Chemistry 350. HENDERSON, LARNER.

358. **Chemistry of Enzymes and Their Action.** Fundamental principles involved in the isolation and characterization of enzymes, the specificity and kinetics of their action, and the methods of applying enzymes to the study of metabolic processes. I; ¾ unit. Prerequisite: Chemistry 350 and 355. VESTLING.

395. **History of Science with Particular Reference to Chemistry.** I; ¼ unit. Prerequisite: Twenty hours of laboratory science. BARTOW.

397. **Radiochemistry.** Properties of radioactive nuclei, nature of radioactivity, nuclear reactions, detection equipment, and tracer technique. Lectures. I, II; ½ unit. Prerequisite: Chemistry 240 and 241. DUFFIELD.

398. **Radiochemistry.** Laboratory to accompany Chemistry 397. I, II; ¼ unit. Prerequisite: Chemistry 240 and 241; credit or registration in Chemistry 397; consent of instructor. DUFFIELD.

Chemical Engineering

The Department of Chemistry and Chemical Engineering offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Chemical Engineering. Candidates for these degrees should have had undergraduate training comparable to that offered at the University of Illinois, including mathematics through calculus, and one-year courses in physics, mechanics, and electrical engineering. Students who enter without the usual engineering courses prescribed in the undergraduate chemical engineering curriculum will be required to make up their deficiencies to the extent prescribed by their adviser.

Candidates for an advanced degree in chemical engineering must have had the equivalent of twenty-five hours in chemistry, including organic and physical chemistry.

A reading knowledge of German and French or Russian is recommended for all graduate students in chemical engineering. It is not required of students who are candidates for the master's degree. In meeting the language requirements for the degree of Doctor of Philosophy in Chemical Engineering, a student may substitute Russian for French on the direct recommendation of the Department of Chemistry and Chemical Engineering (and without formal petition), provided that such recommendation is approved by the Dean of the Graduate College.

Candidates for the Master of Science degree in Chemical Engineering must include Chemical Engineering 487 and 488 among their courses.

A student who chooses chemical engineering as a minor must take at least two units of work in this subject for the Master of Science degree, or four units for the Doctor of Philosophy degree.

COURSES FOR GRADUATES

464. **Diffusional Operations.** Lectures. I; 1 unit. Prerequisite: Chemical Engineering 373. JOHNSTONE.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. I, II; ¼ unit. Prerequisite: Chemical Engineering 373. DRICKAMER, JOHNSTONE.

466. **Filtration and Separations.** Properties of particulate matter: aerosols, suspensions, slurries, and packed beds; methods of comminution and separation. Lectures and problems. II; ¾ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Chemical Engineering 373. JOHNSTONE.

467. **Distillation.** Application of principles of distillation to binary and multicomponent mixtures including a discussion of azeotropic and extractive distillation. II; ¾ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Chemical Engineering 373. DRICKAMER.

468. **Advanced Plant Design.** Problems in equipment design and plant layout. Lectures and conferences. II; ¾ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Chemical Engineering 373, 387, and 388. JOHNSTONE.

469. **Industrial Reaction Kinetics and Catalysis.** Prediction of physical properties and absolute reaction rates; application to design of industrial reactors. II; 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Consent of instructor. DRICKAMER.

487. **Flow of Fluids.** Advanced course. Lectures, recitations, and problems. I; ¾ unit. Prerequisite: Chemical Engineering 371, or equivalent with consent of instructor. HANRATTY.

488. **Heat Transmission.** Advanced course. Lectures, recitations, and problems. I; ¾ unit. Prerequisite: Chemical Engineering 371, or equivalent with consent of instructor. WESTWATER.

490. **Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the degree of Doctor of Philosophy. Not all candidates for thesis work necessarily will be accepted. Any student whose major is in another department must receive permission from the Head of the Department to register in this course. I, II; ¼ to 4 units. Work may be taken in chemical engineering (including bioengineering) subject to the approval of the qualified staff members. DRICKAMER, FINN, JOHNSTONE, PETERS, STRAUB, SWANN, WESTWATER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Process Engineering.** Same as Food Technology 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food technology; not open to majors in chemical engineering. Lectures and problems. I; ¾ unit. Prerequisite: Chemistry 240 or 247; one year of calculus. FINN.

370. **Chemical Engineering Thermodynamics.** The fundamental concepts and laws of thermodynamics. Primarily for students in chemical engineering. II; ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 240. DRICKAMER.

371. **Principles of Chemical Engineering.** Scientific principles in unit operations of chemical engineering. Lectures, problems, and quizzes. I, II; 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor. PETERS.

372. **Unit Operations Laboratory.** First course. To accompany Chemical Engineering 371. I, II; ¼ unit. Prerequisite: Credit or registration in Chemical Engineering 371. HANRATTY, WESTWATER.

373. **Principles of Chemical Engineering.** Scientific principles in unit operations of chemical engineering. Lectures, problems, and quizzes. I, II; 1 unit. Prerequisite: Chemical Engineering 371. DRICKAMER, WESTWATER.

374. **Unit Operations Laboratory.** Second course. To accompany Chemical Engineering 373. I, II; ¼ unit. Prerequisite: Credit or registration in Chemical Engineering 373. FINN, HANRATTY.

377. **Chemical Engineering Technology.** Study of industrial chemical processes and principles. II; ½ unit. Prerequisite: Chemical Engineering 261. WESTWATER.

379. **Chemical Engineering Projects.** Laboratory. Development of an individual project. I, II; ½ unit. Prerequisite: Senior standing in chemistry or chemical engineering. FINN, JOHNSTONE.

380. **Chemical Engineering Calculations.** Numerical and graphical methods for problems in equilibria and kinetics. Lectures and recitations. II; ¾ unit. Prerequisite: Chemistry 344; Chemical Engineering 371. JOHNSTONE.

381. **Chemical Engineering Plant Design.** Comprehensive problems. I, II; ½ unit. Prerequisite: Chemical Engineering 373. PETERS.

382. **High Pressure Reactions.** Lectures, recitations, and problems. I; ½ unit. Prerequisite: Senior standing in chemical engineering or, with consent of instructor, graduates or seniors in chemistry. DRICKAMER.

384. **Power Plant and Boiler Water Problems.** I; ½ unit. Prerequisite: Senior standing in chemical engineering. STRAUB.

385. **Bioengineering.** Study of the chemical processes and principles used in the production of foodstuffs, pharmaceuticals, and fine chemicals. Primarily for students in chemical engineering. May be substituted for Chemical Engineering 377 and 374 in the chemical engineering curriculum. Lectures and laboratory. Laboratory may be omitted by graduate students. I; 1 to 1¼ units. Prerequisite: Credit or registration in Chemical Engineering 373. Finn.

386. **Bioengineering.** Principles of chemical engineering applied to the fermentation and allied industries. May be used as an advanced elective and as a substitute for Chemical Engineering 379 in the chemical engineering curriculum. Lectures and laboratory. II; 1¼ units. Prerequisite: Bacteriology 300, Chemistry 234 and 240, or consent of instructor. Finn.

CITY PLANNING AND LANDSCAPE ARCHITECTURE

The Department of City Planning and Landscape Architecture offers graduate work leading to the Master of Fine Arts and Master of Science degrees. Students applying for admission must have a grade-point average of at least 3.5 for that portion of the work which represents the last fifty per cent of the hours earned toward the bachelor's degree, exclusive of required courses in physical education and military training. Students on limited status will be admitted.

Degree of Master of Science in City Planning. College graduates in architecture, city planning, civil engineering, landscape architecture, and the social sciences are offered an opportunity to prepare themselves for careers in city, state, and regional planning. After completing their preparation they will be qualified for positions with city, metropolitan, state, and regional planning commissions and with planners in independent practice.

The prerequisite for graduate work in city planning is a bachelor's degree in architecture, city planning, civil engineering, landscape architecture, or the social sciences, and must include courses of the following character or their acceptable equivalent: city planning (introductory), three hours; sociology (urban, rural, or regional), three hours; political science (municipal government and problems; public administration), three hours; economics (theory and practice of modern economic society; urban land economics; public finance), three hours.

To qualify for this degree a student must take the seminar and thesis course for three units and at least five additional units to be chosen from the following fields: architecture, civil engineering, economics, geography, political science, sociology. With proper authorization the student may make selection from these or other graduate courses having a close relationship to the city planning field.

Degree of Master of Fine Arts in Landscape Architecture. The prerequisite for graduate work in landscape architecture is a bachelor's degree in landscape architecture substantially equivalent to the degree conferred by the University of Illinois.

To qualify for this degree a student must take the seminar and thesis course for three units, and at least five additional units chosen from the following: Architecture (advanced undergraduate courses in design or history), one unit; Botany (advanced undergraduate or graduate courses), one unit; Civil Engineering 423, one unit; Landscape Architecture 436, one to two units; Landscape Architecture 447, one to two units; Landscape Architecture 457, one to two units.

FELLOWSHIPS

The St. Louis (Missouri) Metropolitan Planning Fellowship is offered by the St. Louis Regional Planning and Construction Foundation to a qualified student

who is a resident of the St. Louis area (within a radius of one hundred miles of St. Louis) and who plans to enroll in the Graduate College to work for a master's degree in city planning. Requests for information and information blanks should be addressed to the Graduate College, 109 Administration Building (East), Urbana.

GRADUATE TEACHING FACULTY

Professors: K. B. Lohmann (Head of Department), H. Bartholomew, W. M. Keith, S. H. White, J. Wood.

City Planning

COURSES FOR GRADUATES

437. **Advanced City Planning Design.** Analysis and synthesis of problems and possibilities in the layout of average towns and cities and their surroundings. I, II; 1 to 2 units. Prerequisite: Enrollment for master's degree in city planning.
487. **Seminar.** I, II; ½ unit.
491. **Thesis.** I, II; ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **City Planning Design.** I; 1 unit. Prerequisite: Landscape Architecture 236 or consent of instructor.
338. **City Planning Design.** II; 1 unit. Prerequisite: City Planning 337 or consent of instructor.
372. **Theory and Practice.** The unified development of communities, comprehensive arrangement of land uses and land occupancy. I, II; ½ unit. Prerequisite: Junior standing.
376. **Planning Procedures, Methodologies, and Practice.** Procedures involved in major types of planning services, special planning studies, planning techniques and methodologies, organization, and administration of planning staffs and agencies, professional practice. I; ½ unit. Prerequisite: Senior standing in city planning or landscape architecture, or consent of instructor.

Landscape Architecture

COURSES FOR GRADUATES

436. **Advanced Landscape Design.** Landscape design of large private, semi-public, and public properties. I, II; 1 to 2 units.
447. **Advanced Landscape Construction.** Construction problems connected with large private and public landscape developments. I, II; 1 to 2 units.
457. **Advanced Planting Design.** Theory and application of planting design in relation to private, semi-public, and public properties. I, II; 1 to 2 units. White.
487. **Seminar.** I, II; ½ unit.
491. **Thesis.** I, II; ½ to 2 units. Staff.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The graduate student in civil engineering generally follows one of three fields: transportation and municipal engineering, hydraulic engineering, or structural engineering, including soil mechanics and foundations. The work leads to the degree

of Master of Science in Civil Engineering and to the degree of Doctor of Philosophy in Engineering. A prerequisite for graduate work in civil engineering is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired.

The work in sanitary engineering leads to the degree of Master of Science in Sanitary Engineering and to the degree of Doctor of Philosophy in Engineering. The prerequisite for admission to the first year of graduate study is a degree of Bachelor of Science in Sanitary Engineering, or the satisfactory completion of the sanitary option in a course in civil engineering, including basic courses in bacteriology, quantitative chemical analysis, and organic chemistry, or their equivalent in the fields of chemistry and biology.

In order to be admitted to graduate work in civil engineering or sanitary engineering, a student must have an undergraduate grade-point average of at least 3.75 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students will not be admitted on limited status.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or a minor are subject to the review of and must be approved by the Head of the Department.

A pamphlet describing the opportunities for graduate work and research in the Department of Civil Engineering is available upon request to the Head of the Department.

ASSISTANTSHIPS

A number of research assistantships are available in the department. Appointments are for a term of one or two years. Assistants receive a stipend and are exempt from the payment of tuition fees. The stipend is $1,350 for the academic year, covering approximately one-half time devoted to research duties in the Engineering Experiment Station and the remainder to graduate study.

Appointments to research assistantships are made only to students with outstanding records or other excellent qualifications. Appointments are given both to first-year and second-year graduate students, but only rarely to third-year students who have not previously studied at Illinois. In general, a half-time asssitant will require two academic years of residence to obtain the master's degree.

Application blanks for research assistantships are available upon request to the Head of the Department. Applications must be made before March 15 of each year for awards for the year beginning in September.

GRADUATE TEACHING FACULTY

Professors: W. C. Huntington (Head of Department), J. G. Clark, E. Danner, G. H. Dell, J. C. Dietz, J. J. Doland, N. M. Newmark, W. A. Oliver, R. B. Peck, M. O. Schmidt, T. C. Shedd, J. Vawter.

Associate Professors: W. J. Austin, E. E. Bauer, E. R. Bretscher, E. J. Daily, W. W. Hay, W. H. Munse, C. P. Siess, T. H. Thornburn.

Assistant Professors: J. W. Briscoe, V. T. Chow, J. C. Guillou, N. Khachaturian, R. J. Mosborg, J. E. Stallmeyer, T. P. Tung, A. S. Veletsos.

Lecturer: K. Terzaghi.

COURSES FOR GRADUATES

401. **Geodetic Engineering.** Elements of geodesy; principles and practice of precise triangulation, traverse, and levels. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. Schmidt.

402. **Geodetic Engineering.** Astronomic determination of latitude, longitude, and azimuth; systems of plane coordinates; map projections; electronic and special control surveys. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. SCHMIDT.

420. **Highway Pavement Design, I.** Analysis and methods of measurement of road surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper road surface properties, load carrying capacity, wear resistance, stability and durability. I; 1 unit. Prerequisite: Civil Engineering 220 or equivalent. E. DANNER.

421. **Highway Pavement Design, II.** Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. II; 1 unit. Prerequisite: Civil Engineering 420 or consent of instructor. E. DANNER.

422. **Municipal Administration and Engineering.** Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and zoning, building codes and inspection; street lighting; public utilities; city cleaning; recreational development. II; 1 unit. Prerequisite: Bachelor of Science degree in civil enginering or consent of instructor. E. DANNER.

423. **Traffic Planning.** Traffic planning functions; urban and rural master traffic plans; traffic analyses for new streets, highways, and terminal facilities. II; 1 unit. Prerequisite: Civil Engineering 323 or equivalent. E. DANNER.

424. **Airport Design.** Selection of site, soil investigation, layout, drainage, runway design and construction, hangars and other structures, and other civil engineering features of airport design and construction. I, II; 1 unit. Prerequisite: Graduate standing in civil engineering.

425. **Railroad Location and Operation.** Track and traffic capacity, optimum size of train, train performance diagram, train scheduling and make-up improvement of existing lines, examples of modern location. I; 1 unit. Prerequisite: Civil Engineering 203, 226, or equivalent experience, or consent of instructor. HAY.

426. **Railroad Location and Operation.** Roadbeds under load, roadbed stabilization, design of ballast section, ties, rails, and fastenings, economies of grade separation, recent examples of roadway and track problems. II; 1 unit. Prerequisite: Civil Engineering 425, or equivalent, or consent of instructor. HAY.

440. **Water Supply.** Design, pumping machinery, administration, and operation. I; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent. DIETZ.

443. **Sewerage.** Sewer design, construction, maintenance, operation, and financing. II; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent. DIETZ.

444. **Sewage Disposal, Wastes Disposal, and General Sanitation.** Principles and design of sewage treatment and waste disposal works. II; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering, or equivalent. DIETZ.

446. **Water Purification and General Sanitation.** Design of water purification works and principles of sanitation. I; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering, or equivalent. DIETZ.

48. **Sanitary Engineering Laboratory.** Tests of water supply; sewerage; water purification and sewage treatment equipment and processes. I, II; 1 to 2 units. DIETZ.

50. **Hydrology and Flood Control.** Magnitude and frequency of flood flow of streams, minimum flow of streams, and regulation of flow by storage reservoirs; intense rainfall and the development of intensity curves for use in rational run-off formula; unit-graph method of computing flood run-off; flood control and prevention by channel improvement, levees, and reservoirs. I; 1 unit. Prerequisite: Civil Engineering 250 and 351, or equivalent. DOLAND.

52. **Water Resources Planning and Development.** Purposes and techniques of planning water resources developments; methods of evaluating the engineering and economic aspects of water conservation projects developed through the examination of actual proposals. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. DOLAND.

55. **Water Power Engineering.** Preliminary investigations of site, available water supply, machinery selection, design of water passages, arrangement and space allocation in power houses, load curve studies, hydrosteam association, and speed and pressure regulation. II; 1 unit. Prerequisite: Civil Engineering 250 or 450. DOLAND.

57. **Hydraulic Engineering Laboratory.** Design, construction, and testing of individual or semi-individual laboratory studies. Study and discussion of advanced subjects of hydraulic engineering phenomena. I; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. DOLAND.

58. **Open Channel Flow.** Classification of types of flow, channel roughness, backwater curve computations, hydraulic jump analysis, special transitions, canal design, study of supercritical velocity flow, unsteady flow and flood movements; modern developments in open channel flow theory and design practice. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. CHOW.

60. **Structural Analysis.** Basic theory of indeterminate structures; deflections and displacements; continuous beams and frames; virtual work; qualitative and quantitative influence lines. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering and undergraduate course in theory of simple structures. CLARK, OLIVER, VAWTER.

61. **Structural Theory and Design.** General theory of continuity; moment distribution; the column analogy; rigid frame bridges and buildings; fixed and continuous arches; classification of structures from viewpoint of design. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering with a basic course in indeterminate structures. SHEDD, VAWTER.

62. **Structural Theory and Design.** Statically indeterminate trusses; continuous trusses; steel arches; secondary stresses; suspension bridges; long-span roofs; skeleton steel buildings. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering with a fundamental course in indeterminate structures. SHEDD, VAWTER.

63. **Analysis and Design of Prestressed Concrete Structures.** Basic principles of prestressing; study of materials used in prestressed concrete; methods of prestressing; analysis and design of precast, pretensioned, and post-tensioned simple beams; prestressed concrete beams subjected to unsymmetrical bending; statically indeterminate, prestressed concrete structures; design of continuous, prestressed concrete beams. I, II; 1 unit. Prerequisite: Bachelor of Science degree in civil or architectural engineering with undergraduate courses in structures and reinforced concrete design. KHACHATURIAN.

464. **Reinforced Concrete Design.** Theories of action of beams, slabs, and columns of reinforced concrete; codes and specifications and their influence on design; effect of continuity. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with undergraduate courses in structures. SHEDD.

465. **Steel Design.** Design of steel members; codes and specifications for buildings; riveted and welded connections; evolution of bridge specifications; loads and working stresses; economic proportions. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with undergraduate courses in structures. SHEDD.

466. **Behavior of Reinforced Concrete Members.** Studies of the actual behavior and strength of reinforced concrete members by means of critical reviews of the more significant experimental and analytical investigations. Emphasis is placed on the empirical nature of current design specifications and their relation to the results of research. Beams subjected to pure flexure, columns subjected to axial compression, combined flexure and axial compression, combined flexure and shear, and bond. I; 1 unit. Prerequisite: Bachelor of Science degree in civil or architectural engineering with undergraduate courses in structures and reinforced concrete design. SIESS.

467. **Behavior of Reinforced Concrete Structures.** Continuation of Civil Engineering 466. Studies of behavior and strength of statically indeterminate reinforced concrete structures and structural elements: frames, floor slabs in buildings, isolated column footings. II; 1 unit. Prerequisite: Civil Engineering 466 or consent of instructor. SIESS.

469. **Wood Structures.** Theory and practice in the design of modern wood structures; the effect of the plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. I, II; 1 unit. OLIVER.

470. **Earth Pressures and Retaining Walls.** A study of earth pressures considering the significant properties of soils; methods of computing earth pressures and the limitations in their dependability; stability computations; and the design and construction of retaining walls and abutments. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. HUNTINGTON.

471. **Earth and Masonry Dams.** Stability of rolled-fill and hydraulic-fill earth dams and rock-filled dams; methods of construction; seepage losses; control of seepage forces; safety of foundations; solid gravity, arched gravity, arch, multiple arch and slab and buttress dams; safety against sliding and overturning; unit stresses on horizontal sections and principal stresses; joints; drainage; foundations. II; ½ to 1 unit. HUNTINGTON, PECK.

473. **Soil Mechanics.** Advanced studies of research techniques in soil mechanics and foundation engineering. I; 1 unit. Prerequisite: Civil Engineering 374 or consent of instructor. PECK.

474. **Foundation Engineering.** Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. II; 1 unit. Prerequisite: Credit or registration in Civil Engineering 374, or consent of instructor. PECK.

481. **Numerical and Approximate Methods of Stress Analysis.** Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns and frameworks, moments and deflections of beams resting on elastic or plastic supports, vibrations and transient loading of beams and of complex structural assemblies. I or II; 1 to 2 units. AUSTIN, NEWMARK.

32. **Theoretical Bases for Numerical and Approximate Methods of Stress Analysis.** Basic concepts in theory of numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures, buckling and flexure of frameworks, torsion of solid and thin-walled sections, lateral buckling of beams, bending of plates and of stiffened plates, plane stress and axially symmetrical problems in elasticity, and other subjects: I or II; 1 to 2 units. Austin, Newmark.

33. **Analysis and Design of Plates and Shells.** Fundamental theories of bending and buckling of plates, including stiffened plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highway and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs and hipped plate construction. II; 1 to 2 units. Prerequisite: Consent of instructor. Austin, Newmark, Veletsos.

34. **Behavior of Structures Under Dynamic Loads.** Free vibration, forced vibration, and transient response of structures and structural components having one or many degrees of freedom; analyses of the effects of wind load, explosion blast, impact, earth tremors and other time dependent excitations on buildings and bridges; effects of damping and inelastic action; generalized coordinates and Lagrange's equations with application to the analysis of the dynamic response of beams and plates; propagation of stress waves in structural materials; self excited vibrations with application to cables and suspension bridges. I; 1 to 2 units. Prerequisite: Civil Engineering 461 or equivalent. Newmark, Veletsos.

35. **Behavior of Steel Structures.** Studies of the behavior of metal structures; significance in terms of design and development of specifications; critical evaluations of experimental investigations of columns, beams, and frames loaded to failure; strength of riveted, bolted, and welded connections; brittle fracture; fatigue; and impact. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. Munse.

36. **Design of Lightweight Structures.** Analysis and design of structures and structural members of minimum weight. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree with previous work in statically indeterminate structures. Clark.

37. **Design of Structures for Dynamic Loads.** Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast resistant structures; criteria for design of earthquake resistant structures; application to actual problems. II; 1 to 2 units. Newmark.

91. **Thesis (M.S.).** I, II; 1 to 2 units.

92. **Thesis (Ph.D.).** I, II; ½ to 4 units.

93. **Special Problems.** Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who will supervise the work. I, II; ½ to 2 units.

95. **Highway Seminar.** Presentation and discussion of current problems and research developments in highway transportation, administration, and engineering. (Should be followed by Civil Engineering 496.) I; no credit. E. Danner.

496. **Highway Seminar.** A continuation of Civil Engineering 495. Presentatio and discussion of current problems and research developments in highwa transportation, administration, and engineering. II; no credit. E. Danner

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Photogrammetry.** A study of aerial surveying in civil engineering practice Characteristics and interpretation of aerial photographs; stereovision; mo saics; economics of photogrammetry; map reproduction. Practice in th preparation of a topographic map from aerial photographs. I; ½ unit Prerequisite: Civil Engineering 207 (Summer Surveying Camp); senio standing or consent of instructor.

319. **Advanced Surveying.** Advanced problems in topographic engineering; control surveys, special mapping projects, construction surveys, and specia surveys. The utilization of maps and survey data in civil engineering practice. II; ½ unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp); senior standing or consent of instructor. Schmidt.

323. **Highway Traffic Characteristics.** Driver characteristics, vehicle characteristics, and traffic behavior as related to highway design and operation; traffic studies, field problems. I; 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

332. **Engineering Properties of Soils.** Laboratory practice in testing, identification, and classification of soils; study of development of test procedures and basic theories involved; calculations and preparation of graphs using test data. Tests include those for classification, determination of physical properties, and job control. I, II; ½ unit. Prerequisite: Senior standing in engineering or consent of instructor. Bauer.

344. **Water and Sewage Treatment.** Principles, design, and operation of water purification and sewage treatment works. I; 1 unit. Prerequisite: Credit or registration in Bacteriology 104 and Civil Engineering 240 or 241. Dietz.

345. **Public Health Engineering.** Principles of sanitation, waste collections, and disposal; sanitary regulations, biostatistics. II; ½ unit. Prerequisite: Credit or registration in Bacteriology 104. Dietz.

351. **Drainage and Flood Control.** Land drainage, river improvement, flood control. II; ½ unit. Prerequisite: Civil Engineering 250. Doland.

355. **Water Power Engineering.** Analysis of hydrologic and power market data; selection of site and hydraulic machinery; preliminary design of water passages and power house; formal reports on projects. II; 1 unit. Prerequisite: Civil Engineering 250. Doland.

356. **Hydraulic Engineering Laboratory.** Fundamental principles, operation and use of model laboratories, dimensional analysis, hydraulic similitude, theory and design of hydraulic models. II; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. Guillou.

359. **River Hydraulics.** Gaging of streams, stream erosion and deposition, use of groins, revetments and mats, stream systems, and river navigation. I; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232. Doland, Guillou.

361. **Statically Indeterminate Structures.** Elastic theory and its applications to statically indeterminate structures. I, II; ½ unit. Prerequisite: Civil Engineering 262; credit or registration in Civil Engineering 264.

362. **Statically Indeterminate Structures.** I, II; ½ unit. Prerequisite: Civil Engineering 361, or 262 and consent of instructor.

370. **Foundations and Retaining Walls.** Evaluation of sub-soil conditions as they affect the behavior, proportions and choice of type of foundations; relations

between foundation and other structural problems; design and construction of retaining walls and abutments including the study of earth pressure theories; applicability of analytical methods used to other problems involving natural phenomena. I, II; 1 unit (special problems for graduate credit). Prerequisite: Civil Engineering 230 and 263, or consent of instructor. DAILY.

71. **Earth and Masonry Structures.** Design and construction of gravity masonry dams, earth dams and embankments, rock-fill dams, and the substructure for bridges and buildings. I, II; ½ unit. Prerequisite: Credit or registration in Civil Engineering 264 and 370, or consent of instructor. DAILY.

73. **Introduction to Soil Mechanics.** Identification, description, and physical properties of soils; subsurface exploration; engineering characteristics of natural deposits of soil. I; 1 unit. PECK.

74. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; damage due to construction operations. II; 1 unit. Prerequisite: Civil Engineering 373. PECK.

75. **Engineering Aspects of Surficial Soils.** Use of geologic, pedologic, and air-photo information for identification and evaluation of the engineering properties of surficial soils. II; 1 unit. Prerequisite: Civil Engineering 230 or consent of instructor. THORNBURN.

THE CLASSICS

The Department of Classics offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

The degree of Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the degree of Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. In all cases, the requirement of a master's thesis will be waived; extra units of work in Greek or Latin will be substituted for the thesis.

The degree of Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

Students applying for admission must have a 3.5 grade-point average for that portion of the work which represents the last fifty per cent of the hours earned toward the bachelor's degree, exclusive of required courses in physical education and military training. Students on limited status will not be admitted.

All graduate students should take the course in Bibliography and Criticism, Latin 495-496, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a mimeographed bulletin which may be obtained by applying to the Head of the Department.

GRADUATE TEACHING FACULTY

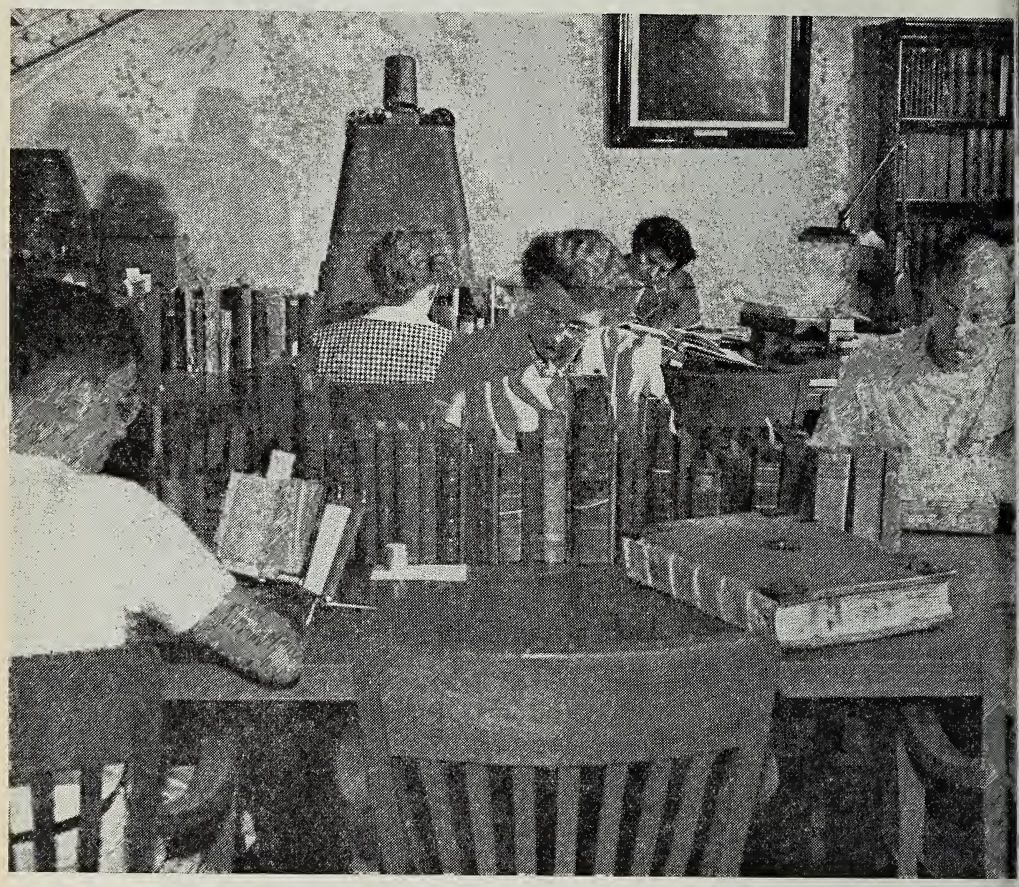
Professors: J. L. HELLER (Head of Department), R. P. OLIVER, B. E. PERRY (on leave 1954-1955), A. TURYN.

Assistant Professor: MARTHA H. LEWIS.

Classics in Translation

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Classical Literary Traditions, I.** Greek literature from Homer to Aristotle. I; ½ unit. Prerequisite: Completion of the foreign language requirement in



A section of the Rare Book Room in the University Library. Open, treme right, The Kelmscott Chaucer printed by William Morris, probal best known of private press books. Closed, in foreground, Thomas Ac *Summa Theologica*, printed by Johann Mentelin, Strassburg, not late 1463.

the College of Liberal Arts and Sciences, or the equivalent. Knowledge of Greek or Latin not required. PERRY.

)2. **Classical Literary Traditions, II.** Literary forms in the Alexandrian and Roman periods. II; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or the equivalent. Knowledge of Greek or Latin not required. HELLER.

reek

Preparation for first-year graduate work in Greek should include at least three ars of college Greek, or equivalent, and two years of college Latin. A reading owledge of German and French is important for candidates in this subject. The udy of history and philosophy is especially recommended.

URSES FOR GRADUATES

In any given semester, a selection from the following courses will be offered demand. Consult the departmental office, 126 Lincoln Hall, well in advance registration.

Unless otherwise noted, the prerequisite to all courses is three years of college reek.

1. **Hellenistic Literature.** I, II; 1 unit. PERRY.
2. **Lucian and His Age.** I, II; 1 unit. PERRY.
3. **Greek Lyric Poetry.** I, II; 1 unit. TURYN.
4. **Greek Drama: Tragedy.** I, II; 1 unit. PERRY.
5. **Homer.** I, II; 1 unit. TURYN.
6. **Thucydides.** I, II; 1 unit. HELLER.
2. **Plato.** I, II; 1 unit. TURYN.
4. **Greek Drama: Comedy.** I, II; 1 unit. PERRY.
1. **Greek Literary Criticism.** I, II; 1 unit. TURYN.
2. **Greek Oratory.** I, II; 1 unit. TURYN.
1. **Greek Epigraphy.** I, II; 1 unit. Prerequisite: Two years of college Greek and one year of ancient history. HELLER.
1. **Greek Archaeology.** Methods and principles of Greek archaeology, as exemplified in the study of pottery, sculpture, architectural remains, coins, and inscriptions. I, II; 1 unit. Prerequisite: One year of ancient history or consent of instructor. Knowledge of Greek not required. LEWIS.
1. **Research in Special Topics.** Same as Latin 491. Guidance in writing theses for advanced degrees. I, II; 1 to 4 units. HELLER, PERRY, TURYN.

URSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

8. **Elements of Technical Terminology.** Presentation and analysis of Greek and Latin prefixes, suffixes, and root-words basic in the vocabularies of modern science, especially botany, psychology, zoology, and medicine. I, II; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or the equivalent, or completion of twenty hours of science or architecture. Knowledge of Greek or Latin not required. HELLER, LEWIS.
1. **Readings in Greek Literature.** Supervised reading, topics to be chosen according to need, in consultation with the adviser. Suggested topics (others are possible): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Menander, Oratory, New Testament, Survey of Greek Literature. Prerequisite:

Two years of college Greek; consent of instructor. This course may be re peated for credit to a maximum of 2 units. I, II; ½ to 1 unit. HELLEI LEWIS, PERRY, TURYN.

Latin

Preparation for first-year graduate work in Latin should include at least tw years of preparatory Latin and three years of college Latin. A reading knowledg of French and German is important. Some acquaintance with Greek is highl desirable, and the study of history and philosophy is especially recommended.

Candidates for the degree of Master of Arts in the Teaching of Latin mu earn four units in Latin, two units in education, and two units in electives. A least two of the four required units in Latin must be in courses numbered abo 400; the other two units may be chosen in whole or in part from the followir list: Latin 311, 312, and 391. The required work in education consists of Edu cation 311 and 312 and one unit selected from Education 301, 302, 303, 30 The electives may be in Latin, in Greek, in education, or, in exceptional cases, other fields. The courses in Latin and the electives must be selected with th approval of the adviser, Professor J. L. Heller, 126 Lincoln Hall.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses will be offere on demand. Consult the departmental office, 126 Lincoln Hall, well in advance registration.

Unless otherwise noted, the prerequisite to all courses is four years of colle Latin or equivalent.

409. **History of the Latin Language.** I, II; 1 unit. Prerequisite: Two years college Latin, or equivalent, and two years of a modern foreign languag HELLER.
410. **Vulgar Latin.** I, II; 1 unit. Prerequisite: Two years of college Latin, equivalent, and two years of a Romance language. HELLER.
411. **Latin Epigraphy.** I, II; 1 unit. Prerequisite: Three years of college Lati or equivalent, and one year of ancient history. OLIVER.
412. **Latin Elegy.** I, II; 1 unit. OLIVER.
413. **Caesar.** I, II; 1 unit. TURYN.
414. **Lucan.** I, II; 1 unit. OLIVER.
415. **Lucretius.** I, II; 1 unit. PERRY.
416. **Vergil.** I, II; 1 unit. TURYN.
421. **Horace.** I, II; 1 unit. TURYN.
422. **Plautus and Terence.** I, II; 1 unit. HELLER.
423. **Latin Romance.** I, II; 1 unit. PERRY.
425. **Cicero.** I, II; 1 unit. TURYN.
426. **Tacitus.** The *Annales*. I, II; 1 unit. OLIVER.
427. **Roman Satire.** I, II; 1 unit. PERRY.
441. **Latin Paleography.** I, II; 1 unit. OLIVER.
462. **Topography and Monuments of Ancient Rome.** I, II; 1 unit. Prerequisi One year of ancient history or consent of instructor. Knowledge of La not required. LEWIS.
491. **Research in Special Topics.** Same as Greek 491. Guidance in writing the for advanced degrees. I, II; 1 to 4 units. HELLER, OLIVER, PERRY, TUR

495. **Bibliography and Criticism.** Introduction to the methods and techniques of scholarship. I; ½ unit. OLIVER.

496. **Bibliography and Criticism.** II; ½ unit. OLIVER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Advanced Latin Composition.** Practice in the writing of Latin prose. I; ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major. TURYN.

312. **Advanced Latin Composition.** II; ½ unit. Prerequisite: Latin 311. TURYN.

391. **Readings in Latin Literature.** Supervised reading, topics to be chosen according to need, in consultation with adviser. Suggested topics (others are possible): Livy, Horace, Vergil, Cicero's *Orations,* Seneca, Ovid, Cicero's *Essays,* Patristic Latin, Medieval Latin. I, II; ½ to 1 unit. Prerequisite: Three years of college Latin, or equivalent; consent of instructor. This course may be repeated for credit to a maximum of 2 units. STAFF.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. This work is given in five hief fields of specialization: dairy bacteriology, dairy biochemistry, dairy cattle eeding and nutrition, dairy cattle breeding and genetics, and physiology of reproduction, each calling for a somewhat different undergraduate preparation and raduate program. Students majoring in dairy science may select one of these reas of study for the master's or doctor's degree. Students interested in the conomics of milk production normally will major in the Department of Agricultural Economics. For the Master of Science degree, students may elect to confine heir work entirely to the major. If a minor is chosen, it must be in another epartment. For the Doctor of Philosophy degree, students may select a sole inor in another department, or a first minor and a second minor, the first of hich may be in a field closely allied to the area of specialization of the major; he second must be taken in another department. The amount of graduate credit equired in each case is dependent upon the specifications of the Graduate College nd the department in which the minor is chosen. Students selecting dairy bacriology or dairy biochemistry as areas of specialization for the major in dairy cience should expect and be prepared to elect some branch of chemistry as one f the minors for an advanced degree.

For admission to full standing, an applicant's undergraduate grade-point verage must be at least 3.5 for that portion of work which represents the last fty per cent of the hours completed to secure the bachelor's degree, exclusive of equired physical education and military training. Limited status students will be ccepted.

For a major in dairy science for either advanced degree, students must select, ith the advice of the Head of the Department, a faculty adviser in the separate rea of study desired. A faculty adviser will specify course requirements including ossible deficiencies to be removed for the degree sought and their sequence, and ill direct the research and the preparation of the thesis. Candidates for the egree of Master of Science must complete one-half unit of Dairy Science 490, nd two units of Dairy Science 493 or 494. For the degree of Doctor of Philosphy, one and eight units, respectively, of these courses must be completed. ther course requirements depend upon the separate area of study in which the udent specializes and upon his background training. Information concerning ch requirements may be obtained from the departmental office, 315 Animal iences Laboratory.

Candidates for the degree of Master of Science are expected to complete a acceptable thesis unless conditions warrant waiver of this requirement which m be done only upon petition to and permission of the Dean of the Gradua College. All students expecting to continue graduate studies should fulfill t thesis requirement. A comprehensive examination concerning the thesis and t general field of dairy science is a departmental requirement for the degree Master of Science.

For a minor in dairy science, students should select a minor adviser in t area of study of their choice and determine with that adviser the specific cours required. For the degree of Master of Science, the minimum requirements for first minor are two units in dairy science, and for a second minor, one unit dairy science.

For the degree of Doctor of Philosophy, the minimum requirements for sole minor are four to six units of dairy science of which three units must be 400 numbered courses; for a first minor, four units in dairy science; and for second minor, two units in dairy science.

ASSISTANTSHIPS

Teaching and research assistantships are available each year to candida for either advanced degree. Most of these assistantships are on a half-time ba and involve a reduced study schedule as outlined in the general regulations of t Graduate College. Inquiries and applications should be addressed directly to t Head of the Department.

GRADUATE TEACHING FACULTY

Professors: G. W. Salisbury (Head of Department), K. E. Gardn W. W. Yapp.

Associate Professors: R. G. Hansen, K. A. Kendall, W. O. Nelson, N. VanDemark.

Assistant Professors: R. L. Hays, B. L. Larson, R. W. Touchberry, W. Wood.

COURSES FOR GRADUATES

405. **Economic Milk Production.** II; 1 to 2 units. Yapp.

408. **Physiology of Lactation.** II; ½ to 2 units. Hays.

411. **Population Genetics and Animal Breeding.** Same as Animal Science 4 The mathematical theory of population genetics and its application to improvement of farm animals. Results of different systems of mating the expected gains from different methods of selection. A knowledge elementary algebra is essential. II; 1 unit. Prerequisite: Dairy Science or equivalent. Touchberry.

430. **Physiology of Mammalian Germ Cells.** A literature and laboratory co covering the recent theories and developments on the formation, transpo tion, and livability of spermatozoa and ova within the body, and t metabolism and preservation *in vitro*. II; 1 unit. Prerequisite: Dairy S ence 330, Animal Science 406, Chemistry 350; or consent of instruc Salisbury, VanDemark.

450. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. II; ½ to 2 units. Prerequisite: Dairy Science 150, 151, and 350. Nels Wood.

453. **Dairy Bacteriology Seminar.** Review of current literature in dairy bact ology, and discussion of current problems. II; ½ unit. Nelson, Wood.

480. **Dairy Chemistry.** Assigned problems. I, II; ½ to 2 units. Hansen, Lars

)0. **Dairy Science Seminar.** Current literature relating to various phases and areas of dairy science. I, II; ½ unit. SALISBURY.

)3. **Research.** Work may be taken in the following subjects: dairy bacteriology, dairy biochemistry, dairy cattle breeding and genetics, dairy cattle feeding, dairy cattle physiology, milk production. Graduate students writing a thesis should so indicate when registering. I; 1 to 4 units. GARDNER, HANSEN, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOOD, YAPP.

)4. **Research.** Work may be taken in the following subjects: dairy bacteriology, dairy biochemistry, dairy cattle breeding and genetics, dairy cattle feeding, dairy cattle physiology, milk production. Graduate students writing a thesis should so indicate when registering. II; 1 to 4 units. GARDNER, HANSEN, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOOD, YAPP.

)URSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

)5. **Genetics and Animal Improvement.** Same as Animal Science 305. The principles of heredity and their application to the problems of animal improvement. II; ¾ unit. Prerequisite: Dairy Science 110 or equivalent. ROBERTS, TOUCHBERRY.

1. **Problems in Dairy Farming.** Dairy farm operation, including field and building arrangement, cropping systems, herd management, sanitary milk production, and farm marketing problems. Lectures, quiz, assigned readings, and problems. I; ¾ unit. Prerequisite: Dairy Science 100 and 202. YAPP.

0. **Special Problems.** I, II; 1 unit. Prerequisite: Approval of head of department. GARDNER, HANSEN, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOOD, YAPP.

0. **Reproduction and Artificial Insemination of Farm Animals.** The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. I; ¾ unit. Prerequisite: Zoology 104 and either Dairy Science 100 or Animal Science 100. VANDEMARK.

4. **Marketing Dairy Products.** Same as Agricultural Economics 334 and Marketing 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

0. **Advanced Dairy Bacteriology.** A systematic study of the cultural, physiological, and biochemical properties of micro-organisms; the application of principles to problems concerning the microflora of milk, milk products, and the bovine digestive system. I; 1 unit. Prerequisite: Bacteriology 104; Chemistry 122 and 132, or equivalent. NELSON, WOOD.

1. **Dairy Biochemical Laboratory Methods.** Theory and application of dairy biochemical laboratory methods: proximate analysis, spectrophotometry, chromatography, protein separation, microtechniques, micro respiration and others. II; 1 unit. Prerequisite: Quantitative analysis, organic chemistry, and consent of instructor. Biochemistry recommended. HANSEN, LARSON.

ONOMICS

The Department of Economics offers graduate work leading to the degrees of ster of Arts, Master of Science, and Doctor of Philosophy.

An applicant's undergraduate grade-point average must be at least 3.5 fc that portion of work which represents the last fifty per cent of the hours con pleted to secure the bachelor's degree, exclusive of required physical education an military training. Students on limited status will not be admitted.

Students who wish to make economics their major subject for an advance degree must have had at least twenty-seven hours of undergraduate work in soci science, fifteen of which must have been in economics; the work in economi must include a course in principles of economics, a course in statistics, and oth courses for which the course in principles is a prerequisite. Students in oth departments who wish to take a minor in economics must have had at lea twelve hours in social sciences, eight hours of which must have been in economic consisting of a course in principles of economics and other courses for which tl course in principles is a prerequisite. Students who can not meet these requir ments may register for graduate work but, unless specifically exempted because superior scholarship or for other reasons satisfactory to the adviser in charg must remove any deficiencies during the first year of residence by taking pr scribed courses without graduate credit.

A first-year student whose major is economics must take either Economi 400-401 or 402-403. If a minor is taken outside the department, two units work will ordinarily be required. Undergraduate courses that are approved f graduate credit may be taken in lieu of graduate courses but not to exceed a tot credit of two units.

A student who wishes to become a candidate for the Doctor of Philosopl degree with a major in economics must pass a preliminary examination showi (1) a detailed knowledge of economic theory and its history; (2) a detail knowledge of certain special fields of economics or allied fields, the number a selection of which is to be determined by the adviser in consultation with t student; and (3) a general acquaintance with the subject matter and bibliograp of other branches of economics. In the work offered in some related field outsi the department the student will be expected to satisfy the examiners as to l proficiency in that subject.

A student who chooses economics as a minor for the Doctor of Philosopl degree must take at least two units of work in this department.

ASSISTANTSHIPS

The Department of Economics awards for each academic year a limit number of assistantships to graduate students in economics. These ordinarily pr vide a stipend of $1,350 plus tuition for half-time teaching or research, or $6 plus tuition for quarter-time service. Under general policy of the departme these assistantships are awarded only to those who have their master's degree the equivalent. In exceptional cases, however, particularly where the scholas records are outstanding, quarter-time assistantships are granted persons with graduate training.

Prospective graduate students in economics who seek assistantships in t department should submit applications not later than March 1 preceding t academic year for which appointment is sought. Requests for application for and for any additional information regarding these assistantships should be a dressed to the Chairman of the Department of Economics, University of Illinc Urbana, Illinois.

GRADUATE TEACHING FACULTY

Professors: H. K. Allen (Chairman of Department), V L. Bassie, J. Bell, W. E. Chalmers, J. F. Due, D. P. Flanders, H. M. Gr R. W. Harbeson, D. L. Kemmerer, D. P. Locklin, R. W. May

E. B. McNatt, W. H. McPherson, R. I. Mehr, W. A. Neiswanger, R. M. Nolen, D. W. Smythe, G. A. Steiner, P. M. Van Arsdell.

Associate Professors: Grace Beckett, H. Brems, R. Ferber, F. B. Haworth, G. Kleiner, J. L. McConnell, R. C. Osborn, D. W. Paden, J. B. Parrish, W. C. Robb, W. Woodruff.

Assistant Professors: J. A. Cochran, Janet L. Weston.

Instructor: H. E. Shuman.

COURSES FOR GRADUATES

00. **General Economic Theory.** A preliminary survey of business, labor, government, monetary, and other institutional aspects of economics, followed by a more extended analysis of theoretical economics and the application of this theory to some of the problems raised in the preliminary survey. Intended for students whose minor is economics and other students who have only the minimum preparation for graduate study in economics. I; 1 unit. Prerequisite: Economics 102 and 103, or 108. Flanders.

01. **General Economic Theory.** A preliminary survey of business, labor, government, monetary, and other institutional aspects of economics, followed by a more extended analysis of theoretical economics and the application of this theory to some of the problems raised in the preliminary survey. Intended for students whose minor is economics and other students who have only the minimum preparation for graduate study in economics. II; 1 unit. Prerequisite: Economics 102 and 103, or 108. Flanders.

02. **Economic Theory.** The principles of economics, with special emphasis on value and distribution, for students whose major is economics and others who have had a thorough training in economics. I; 1 unit. Prerequisite: At least twenty-seven hours of undergraduate work in social sciences, fifteen of which must have been in economics; the work in economics must include a course in the principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite.

03. **Economic Theory.** The principles of economics, with special emphasis on value and distribution, for students whose major is economics and others who have had a thorough training in economics. II; 1 unit. Prerequisite: At least twenty-seven hours of undergraduate work in social sciences, fifteen of which must have been in economics; the work in economics must include a course in the principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite.

04. **Economic Fluctuations and Stabilization Policies.** An examination of business cycle theory (as distinct from general employment theory) and of alternative proposals for economic stabilization through governmental fiscal, monetary, and other operations. I; 1 unit. Prerequisite: Economics 422 or consent of instructor.

05. **Seminar in National Income and Employment Theory.** A study of the more complex and comprehensive attempts to construct economic models explaining the determinants of the level of employment, and of their use in policy formation. Individual research projects of a statistical or purely theoretical nature. II; 1 unit. Prerequisite: A course in employment theory.

06. **A History of Economic Thought.** Development of economic thought from early times to the present. I; 1 unit. Bell.

07. **History of Economic Thought.** Development of economic thought from early times to the present. II; 1 unit. Bell.

08. **Mathematical Introduction to Macro-Economics.** Systematic treatment (with the help of appropriate mathematical tools) of the equilibrium level and

fluctuations of the major economic variables. II; 1 unit. Prerequisite: Mathematics 142 or 147, Economics 303, or consent of instructor.

410. **Comparative Economic Systems.** The economics of capitalism, socialism, communism, and fascism. I; 1 unit. McConnell.

412. **Advanced Topics in Micro-Economics.** Selected topics in the theory of behavior of the basic economic units — household and firm — treated with the help of mathematical tools. I; 1 unit. Prerequisite: Mathematics 142 or 147, Economics 403, or consent of instructor.

414. **Public Finance.** An analysis of the economics of public expenditures, administration of public funds, intergovernmental fiscal relations, non-tax revenues, public borrowing, debt management, and fiscal policy. I; 1 unit. Prerequisite: Six hours of economics. Allen, Due.

415. **Economics of Taxation.** An analysis of the economics of taxation, with respect to distribution of tax burden, incidence of taxation, and the place in the tax system of the major taxes, particularly the personal and corporation income, sales and excise, property, and death taxes. II; 1 unit. Prerequisite: Six hours of economics. Allen, Due.

418. **Contemporary Economic Problems and Literature.** This course gives the student an opportunity to read critically some of the books which are significant in contemporary economic literature but which he has not read in other courses. S; ½ unit.

420. **Monetary Theory and History.** An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. I, II; 1 unit. Nolen.

422. **Theory of Aggregate Income.** A comprehensive introduction to the theory of the determinants of the level of aggregate income. I, II; 1 unit. Prerequisite: Consent of instructor.

428. **International Economics and Finance.** Analysis of international monetary standards; of their effects on domestic income levels, finance, and central bank problems. I; 1 unit. Kleiner.

429. **International Economics and Finance.** Governmental policies designed to maximize domestic welfare through international exchange of goods and services and through international investment. II; 1 unit. Kleiner.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 336. I; 1 unit. Kemmerer.

437. **Research in American Economic History.** Training in principles of historical method and research, application of economic principles to the study of American economic history, the use of biographical materials, and the use of technical aids to research such as microfilm, tape recorders and questionnaires. Case method is used. Prerequisite: Economics 336 or 436 and a course in economic principles, or consent of instructor. II; 1 unit. Kemmerer.

438. **Seminar in the Economic History of England Since the Beginning of the Industrial Revolution.** British economic and social history from the rise of industrial society: the land and agriculture; population; the revolution in transportation and communications; the progress of industrial techniques; trade and commercial policy; financial policy; economic fluctuations; the working class movement; the rise of the welfare state; from Empire to Commonwealth. I, II; 1 unit. Woodruff.

40. **Labor Economics.** Same as Labor and Industrial Relations 440. A critical economic analysis of contemporary English and American wage theory, employment and unemployment, and collective bargaining, with emphasis on public policy. I; 1 unit. Prerequisite: Six hours of economics. McNatt.

41. **Labor Economics.** Same as Labor and Industrial Relations 441. A critical economic analysis of contemporary English and American wage theory, employment and unemployment, and collective bargaining, with emphasis on public policy. II; 1 unit. Prerequisite: Six hours of economics. McNatt.

42. **Problems and Practices in Collective Bargaining.** Same as Labor and Industrial Relations 442. Seminar in the methods and techniques of collective bargaining in the negotiation of the labor contract; nature and significance of labor agreements; union, management, and public interests in major contract provisions. I; 1 unit. Prerequisite: Consent of instructor. McPherson.

43. **Problems and Practices of Labor Dispute Settlement.** Same as Labor and Industrial Relations 443. Seminar in the techniques of labor contract administration; comparative study of grievance procedure operation; analysis of conciliation, fact-finding, and arbitration procedures, including case studies of arbitration awards. II; 1 unit. Prerequisite: Consent of instructor. McPherson.

44. **The Labor Market.** Same as Labor and Industrial Relations 444. Basic labor force concepts and measurement; economic theory of market operation and contemporary research; long and short run changes in labor force size, composition, mobility, and participation rates; wartime problems of mobilizing labor resources; international aspects, industrial and military, of differential population and labor force growth; public policy and market operation. I; 1 unit. Prerequisite: Six hours of economics. Parrish.

45. **The Labor Market.** Same as Labor and Industrial Relations 445. Concepts, sources of materials, methods of analysis, nature of labor supply; nature of labor demand and recruitment; determinants of interplant occupational mobility with emphasis on the wage structure and the role of wages in allocation of labor supply; adjustment to technological change; problems of the older worker; development of market policy by unions and management; development of public policy including employment service and anti-discrimination programs. II; 1 unit. Prerequisite: Six hours of economics. Parrish.

46. **Trade Unions and the Economy.** Same as Labor and Industrial Relations 446. The economic significance of trade unionism: the role of unions as economic policy making institutions; basic economic criteria in union-management negotiations; union policies and changing technology; unions and social security issues; effect of trade union policies and practices on the functioning of a competitive system. I; 1 unit. Prerequisite: Six hours of economics. Parrish.

47. **Labor Union Organization and Administration.** Same as Labor and Industrial Relations 447. Analysis of the structure and government of the modern American trade union movement with particular reference to the relation between organization and function. Problems relating to the function and execution of economic policies, the maintenance of unity and discipline, the adjustment of jurisdictional conflicts, and the observance of agreements are examined and appraised. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. Chalmers.

54. **Corporation Finance.** Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation;

financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. I; 1 unit. Prequisite: Economics 254. Van Arsdell.

455. **Corporation Finance.** Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. II; 1 unit. Prerequisite: Economics 254. Van Arsdell.

456. **Investment.** A study of the financial process by which savings are transformed into capital with emphasis on the theory of investment, on a critique of investment policy, and on the valuation of investment media. Prerequisite: Six hours of economics. I; 1 unit. Mayer.

460. **Economics of Risk and Insurance.** A study of the nature and cost of risk in our economic society and of the methods of handling it. I, II; 1 unit. Mehr.

470. **Economic Statistics.** Analysis of frequency distributions and patterns of economic behavior. The problem of statistical induction and economic data. The construction and interpretation of index numbers. I; 1 unit. Prerequisite: At least one course in the principles of economics and one in statistical methods. Neiswanger.

471. **Economic Statistics.** Methods of analysis, economic time series; measurement and interpretation of functions in economic data. II; 1 unit. Prerequisite: Economics 370 or equivalent. Neiswanger.

472. **Econometrics.** Same as Mathematics 472. Application of the principles of mathematical statistics to estimation of economic relationships. II; 1 unit. Prerequisite: Credit or registration in Mathematics 364.

473. **Economic Forecasting.** Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgment in evaluating current information, selecting critical factors, and appraising the validity of analytical techniques. II; 1 unit. Prerequisite: One year of statistics. Bassie.

480. **Seminar in the Relations of Government and Business.** Problems in the relations of government and business. Discussions and individual research in selected problems of economic policy arising from the inter-relations of government and business. I; 1 unit. Gray.

481. **Seminar in the Relations of Government and Business.** Problems in the relations of government and business. Discussions and individual research in selected problems of economic policy arising from the inter-relations of government and business. II; 1 unit. Gray.

484. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. I; 1 unit. Locklin.

485. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. II; 1 unit. Locklin.

488. **Government Regulation of Economic Activity.** A critical economic appraisal of the objectives and results of government policy and practice in controlling economic activity. I, II; 1 unit. Steiner.

489. **Industrial Competition and Monopoly.** A study of the economic, legal, and public policy problems presented by industrial concentration and by price making in imperfectly competitive markets. Prerequisite: A course in principles of economics. II; 1 unit. Harbeson.

90. **Individual Study and Research.** Directed reading and research. I, II; ½ to 1 unit. STAFF.

91. **Economics Seminar (A.M. and Ph.D.).** Required of all students writing master's and doctor's theses in economics. I; 1 to 4 units. Master's theses, FLANDERS. Doctor's theses, LOCKLIN.

92. **Economics Seminar (A.M. and Ph.D.).** Required of all students writing master's and doctor's theses in economics. II; 1 to 4 units. Master's theses, FLANDERS. Doctor's theses, LOCKLIN.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

00. **Intermediate Economic Theory and Analysis.** A development of the leading theories and analyses of value and distribution. Problems and policies of price determination of both the firm and the industry and factor pricing are presented at the intermediate level of analysis. I, II; ½ to 1 unit. Prerequisite: Economics 102, 103 or 108, 109. BELL.

01. **Monetary and Employment Theory.** Monetary theory including various versions of the quantity theory of money; the modern theory of the determination of the level of income and employment; theories of money and interest; fiscal and monetary policy; criteria, proposals, critique. II; ½ to 1 unit. Prequisite: Economics 250. COCHRAN.

06. **History of Economic Thought.** A study of the development of economics. Contributions of schools of thought and individual writers are examined as they influenced economic thought and national policy. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. BELL.

12. **Economics of Welfare.** Review of the marginal conditions for maximum welfare. Analysis of the consequences for welfare of economic security, freedom, consumption standards, unemployment, inequality of income distribution, social costs in production, etc. Various philosophies relating to welfare will be examined. II; ½ to 1 unit. Prerequisite: Economics 102 or 108. MCCONNELL.

13. **Economics of Consumption.** Analysis of population, personal income distribution, consumption theories, savings and price movements; aggregate consumption expenditures and consumer choice; applications in the areas of laws affecting consumers, credit and tax policies. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MILLICAN.

26. **Theories and Policies of International Commerce.** Analysis of international trade theories, classical and recent; international commercial policies, past and current; economic development in selected world regions; international commercial agreements and conferences; foreign trade policy of the United States. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108 and 109. BECKETT.

28. **Latin-American Economic Problems.** Economic problems of commerce, finance, transportation, mining, agriculture, and industry in Latin America; Latin-American and international economic relationships. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. BECKETT.

32. **History of the American Labor Movement.** Same as History 332 and Labor and Industrial Relations 332. Development of the labor movement from the seventeenth century to the present; ideas and men who motivated labor and allied reform movements in a socio-economic context. I, II; ½ to 1 unit.

35. **American Financial History.** American monetary history and the development of the present monetary system, the rise of commercial, investment,

and central banks and of other financial institutions, and the financing of major wars. Prerequisite: Economics 250. II; ½ to 1 unit. KEMMERER.

336. **American Economic History.** Westward movement; growth of industry, agriculture, commerce, finance, transportation, trust movement, and labor. I, II; ½ to 1 unit. KEMMERER.

342. **Economics of Social Security.** Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injury. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MCNATT.

343. **Collective Bargaining.** Same as Labor and Industrial Relations 343. Emergence of collective bargaining in American industry; national labor policy and bargaining; impact of bargaining on union and management structures and policies; bargaining processes and techniques; the labor agreement including contract provisions, grievance procedures, arbitration; economic consequences of bargaining; case studies of union-management relationships and problems. II; ½ to 1 unit. Prerequisite: Economics 240. PARRISH.

344. **The Law and Labor.** Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; Economics 240. MCNATT.

346. **Foreign Labor Movements.** Same as Labor and Industrial Relations 346. Analysis of the history, organization, economic policies, political programs and domestic, international, and contemporary influence of the labor movements of Great Britain, Sweden, Germany, France, Latin America, and Russia. I; ½ to 1 unit. Prerequisite: Economics 240. CHALMERS.

359. **Security Analysis.** Application of investment principles to investment policy; analytical principles and techniques; analysis of fixed income corporate securities, of senior securities with speculative features, of common stocks, of governmental and municipal securities, and of investment company securities. Prerequisite: Accountancy 108; Economics 254. II; ½ to 1 unit. MAYER.

363. **Advanced Life Insurance.** A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. II; ½ to 1 unit. Prerequisite: Economics 262. MEHR.

366. **Casualty Insurance.** An examination of hazards, contracts, forms, rates, underwriting principles, and loss prevention activities in the following branches of insurance: workman's compensation, automobile, public liability, burglary, robbery, theft, glass, power plant, credit, accident and health, and fidelity and surety. I; ½ to 1 unit. Prerequisite: Economics 260. MEHR.

367. **Problems in Insurance.** An analysis of problems dealing with the fitting of insurance coverages to the needs of business. The course considers the problems of surveying hazards, selecting policy forms, rating, underwriting, loss adjustment, loss prevention, and over-all insurance planning. II; ½ to 1 unit. Prerequisite: Economics 263 and 366; senior standing. MEHR.

370. **Applied Statistical Analysis.** Same as Mass Communications 370. A general course in statistical methods applied to the subject matter fields of the College of Commerce and Business Administration; intended principally for those students who have entered or intend to enter a program of graduate study and whose training in the basic statistical methods employed in these disciplines is inadequate. I; 1 unit. Prerequisite: Admission to candidacy

for a graduate degree with no more than one course in economic statistics; or in case of undergraduates, thirty hours of commerce subjects. Credit is not to be allowed for this course in addition to that for Economics 271. Neiswanger.

371. **Applied Problems in Sampling.** Design of various types of samples useful in economic and business research; cost limitations and the design of samples; sources of bias and sampling methods; interpretation of the results. I, II; ½ unit. Prerequisite: One course in mathematics; Economics 170 or a similar introductory course in statistics.

372. **Index Numbers.** The theoretical formulation of index numbers and the statistical problems of estimation and measurement for index numbers of price, production, productivity, cost of living, level of living, and preference scales. II; ¼ unit. Prerequisite: Economics 170; Economics 102 and 103, or 108.

373. **Correlations in Business and Economic Data.** A study of the measurement of relationships among economic and business data. Methods for expressing these relationships (correlation, analysis of variance, chi-square) are studied by examining specific problems in which these techniques have proved to be useful. The use of critical attitudes in the use of statistical tools are emphasized throughout the course. II; ½ unit. Prerequisite: Economics 170, 171, or Economics 271, or equivalent. Paden.

374. **Business Fluctuations and Forecasting.** Analysis of the types of variation in individual industry series and the economy as a whole; use of various indicators of economic conditions. I; ½ to 1 unit. Prerequisite: Economics 170 and 250. Paden.

375. **National Income Analysis.** National income concepts and measurement; an analysis of the general level of output and income in the economic system as a whole and its distribution among individuals, applying empirical data within a framework of national income theory. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. Paden.

376. **Statistics of Labor.** A study of the methods and problems involved in the derivation of "labor statistics" from both the theoretical and practical points of view. The statistical aspects of the measurement, analysis, and interpretation of data on wages, employment, labor force, and productivity are stressed. II; ½ to 1 unit. Prerequisite: Economics 170 or equivalent.

377. **Senior Seminar in Statistics.** The work in the course deals with statistical problems of general interest in economics and business. The topics will be selected to emphasize difficulties of definition, concept, data collection, measurement, and analysis and will serve to bring together the theoretical concepts and methodological tools which have been acquired by the student in preparatory courses. II; ½ to 1 unit. Prerequisite: Economics 170 and 271; credit or registration in Economics 371 (or 372 or 373). Neiswanger and others.

379. **Elements of Econometrics.** The formulation of hypotheses concerning economic relationships, different types of models, the identification and statistical testing of relations, and the efficient computation of numerical estimates. Prerequisite: Consent of instructor. II; 1 unit. West.

384. **Economics of Transportation.** Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. Harbeson, Locklin.

385. **Economic Problems of Commercial Air Transport.** Study of air transport with particular reference to questions of public policy, system of regulation, and regulatory policy. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. Locklin.

386. **Current Transportation Problems.** An analytical and critical study of selected problems of current interest in transportation. II; ½ to 1 unit. Prerequisite: Economics 384. HARBESON.

388. **Economics of National Security.** Analysis of economic aspects of American national security in relation to world problems, economic problems of mobilization, and the impact of national security policies on the economy. Includes problems and policies in the area of industrial production, economic stabilization, manpower allocation, agriculture, foreign economic warfare, military procurement, and facility expansion. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. STEINER.

389. **Industrial Competition and Monopoly.** The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership as alternatives to the antitrust approach. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HARBESON.

390. **Economics of Communications, I.** Same as Journalism 390 and Mass Communications 390. Economic problems associated with the various forms of radio broadcasting including FM, television, and facsimile, and the use of radio for the safety and efficiency of transportation, protective services, etc. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

391. **Economics of Communications, II.** Same as Journalism 391 and Mass Communications 391. Economic problems associated with the following means of communications: motion pictures, newspapers, magazines, and books. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

EDUCATION

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology, elementary school teaching, guidance, history and philosophy of education, home economics education, industrial education, research methods, secondary school teaching, or school psychology.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, excluding required physical education and military training, provided also that the undergraduate preparation is appropriate to advanced study in the chosen major field.

Degree of Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College pertaining to admission, registration, programs, degree requirements, grades, residence, majors and minors, foreign language, and theses (see pages 18-21), the following regulations apply to programs leading to the degree of Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of no more than two units (Education 491-492) is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required of all students. Competence may be demonstrated by satisfactory grades in the required courses or by satisfactory completion of proficiency examinations in those courses. Education 311 and 312 are required. Two courses chosen from Education 301, 302, 303, and 304 are required.

These degrees are usually the first step toward the degree of Doctor of Philosophy in Education. They will also satisfy, in part, the requirements for admission to candidacy for the degree of Doctor of Education.

Degree of Master of Science in the Education of the Deaf. For admission to the curriculum for the degree of Master of Science in the Education of the Deaf, one of the following prerequisites is necessary: (1) a bachelor's degree in elementary or special education (other than education of the deaf), or (2) a bachelor's degree in education of the deaf from an accredited training center for teachers of the deaf.

Candidates for the degree must earn a minimum of eight units as follows:

(1) Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required.

(2) For those students qualifying under prerequisite (1), Education 417, one unit; Education 319, one or one and one-half units; Education 320, one to two units; Speech 301, one-half unit; Speech 395, one-half unit; and Speech 385, one-half unit, are required. For those students qualifying under prerequisite (2), Education 418, one unit, and Education 449, one unit, are required.

(3) Elective courses should be chosen from Education 381, 412, 425, 426, 430, 440, 456, 460; Psychology 443, 461; Speech 375, 388, 488, 489.

The advisers for candidates for this degree are Professors S. A. Kirk and O. P. Kolstoe, 1003 West Nevada Street.

Degree of Master of Science in the Education of Mentally Handicapped Children. For admission to the curriculum for the degree of Master of Science in the Education of Mentally Handicapped Children, the following prerequisites are necessary: courses sufficient to meet the requirements for an Illinois Teacher's Certificate, and the following undergraduate courses: Education 231, Education 220, and Speech 208.

Candidates for the degree must earn a minimum of eight units as follows:

(1) Required courses: Education 311, one-half unit; Education 312, one-half unit; two courses chosen from Education 301, 302, and 304, one unit; Education 417, one unit; Education 322, one-half unit; Education 323, one-half unit; Education 426, one unit.

(2) Elective courses should be chosen from Education 390, 411, 412, 433; Psychology 338, 406, 411, 445, 461, 467, 493, 494; Speech 385, 388.

The advisers for candidates for this degree are Professors S. A. Kirk and O. P. Kolstoe, 1003 West Nevada Street.

Degree of Doctor of Philosophy. For general requirements for the degree of Doctor of Philosophy, see page 21. A student who wishes to become a candidate for the degree of Doctor of Philosophy with a major in education must have met (1) the academic requirements for the degree of Master of Arts or Master of Science in Education, and (2) have written a thesis. Applicants for admission should present credentials well in advance of the date for their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the student is accepted by an adviser.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Degree of Master of Education. The degree of Master of Education partially fulfills the requirements for admission to candidacy for the Advanced Certificate in Education or the degree of Doctor of Education.

(1) *Admission.* In addition to general requirements, the work presented for admission must include a minimum of sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

(2) *Residence.* At least four units must be earned in residence. If a student is regularly employed for twelve months each year, he must be in residence for four summer sessions during each of which one unit of work is completed.

(3) *Program.* A minimum of eight units of graduate credit is required. Four units must be earned in the field of education. There may be one or two minors with a maximum of four units of minor credit. The general requirements of the Graduate College governing minor fields apply to this degree.

No more than four units of credit earned through any combination of (a) examination for credit in graduate work completed elsewhere, (b) extramural course work, and (c) nonresident campus registration, may be applied toward the degree.

Secondary school teachers who, at the time of first registration, do not hold from the state in which they are employed a certificate valid for every subject which they are teaching will be required to take sufficient courses in the respective subject matter fields to meet the requirements for a valid certificate.

With the prior approval of an adviser, courses in subject matter fields which carry two hundred numbers may be approved for advanced professional credit. Such credit will be computed at the rate of one-quarter unit for each semester hour of credit. The total credit allowed for such courses will not exceed two units. No such credit can be counted toward the requirements of the degrees of Master of Arts, Master of Science, Doctor of Education, and Doctor of Philosophy.

In general, candidates for the degree of Master of Education are expected to take at least two units in fields other than education. This provision is especially applicable to students in secondary education.

Competence in certain fields is required of all students. Competence may be demonstrated by satisfactory grades in required courses or by satisfactory completion of proficiency examinations in those courses. Education 311 and 312 are required. Two courses chosen from Education 301, 302, 303, and 304 are required.

Advanced Certificate in Education. The program leading to the Certificate is designed to provide advanced training for professional workers in specialized areas in education. Students who become candidates for the Certificate will not be considered as beginning work leading to the degrees of Doctor of Education or Doctor of Philosophy.

(1) *Admission.* A candidate for admission must hold a master's degree from an accredited institution. He must have satisfactorily completed at least two years of professional employment in education.

(2) *Residence.* The definition of residence is given on page 21.

(3) *Program.* A minimum of eight units of course work beyond the master's degree is required. Of these no more than three units may be in courses numbered at the 300 level. All course work must be taken on the Urbana campus of the University, except as the adviser may approve in advance plans for study elsewhere. At least four units must be taken in residence at Urbana. Education 311 and 312 are required. Two courses chosen from Education 301, 302, 303, and 304 are also required. Students who have not taken these or equivalent courses prior to entering the program of study leading to the Certificate may meet these requirements by achieving satisfactory grades in the respective courses or by satisfactorily completing proficiency examinations.

Secondary school teachers who, at the time of first registration, do not hold from the state in which they are employed a teacher's certificate valid for every

subject which they are teaching will be required to take sufficient courses in the respective subject matter fields to meet the requirements for a valid teacher's certificate.

With the prior approval of an adviser, courses in subject matter fields which carry 200 numbers may be approved for advanced professional credit. Such credit will be computed at the rate of one-quarter unit for each semester hour of credit. The total credit allowed for such courses will not exceed two units. No such credit can be counted toward the requirements of the degrees of Master of Arts, Master of Science, Doctor of Education, and Doctor of Philosophy.

Degree of Doctor of Education. Programs leading to the degree of Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

(1) *Admission.* A candidate for admission must hold a master's degree from an accredited institution. Admission will be determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

Applicants for admission should present credentials well in advance of the date for their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the student is accepted by an adviser.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

(2) *Residence.* Minimum residence requirements are (a) two consecutive semesters during each of which a minimum of three units of work is successfully completed, or (b) one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

(3) *Program.* A minimum of sixteen units of course work beyond requirements for the master's degree is required. Extramural course work may not be included as part of this sixteen-unit requirement. A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution, may petition for the application of not more than six units of such work toward the program leading to the degree of Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. No more than six units of credit earned at other universities may be included in the minimum sixteen unit requirement.

Education 410, 415, and 496 are required (note prerequisites).

A preliminary examination must be completed satisfactorily prior to beginning the dissertation. A student who has completed a minimum of eight units of course work subsequent to his admission may take the preliminary examination when it is recommended by his adviser. The preliminary examination is given by a committee appointed by the Dean of the Graduate College. The nature of the examination will be determined by the committee. Part of the examination may be written. Part of it must be oral.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion

of proficiency examinations. The thesis required for the degree of Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

A final oral examination is held at least two weeks prior to the date the degree is conferred. The examination committee is appointed by the Dean of the Graduate College. The final examination is primarily concerned with the report of the thesis study, but also extends over the whole field of the candidate's study. It is designed to determine whether or not the candidate has a thorough and mature understanding of the field of education as a whole.

Degree of Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 205.

GRADUATE STUDY IN SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy degree. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an interne. After an applicant is admitted as a graduate student in the department of his choice, his acceptance and his work in this program is subject to review by the Joint Committee on School Psychology, representing the College of Education and the Department of Psychology.

ASSISTANTSHIPS

The College of Education employs a substantial number of graduate assistants who hold temporary part-time appointments which allow them to devote much of their time to graduate study. Most of these appointments provide for half-time duty; others for one-fourth time. The initial rate of pay for half-time assistants is $1,350 for the academic year, or $1,650 for the calendar year, plus exemption from tuition fees in the Graduate College. Since assistantships are offered as a means of facilitating students' programs of graduate study, preference is given to young persons who can provide convincing evidence of ability to do graduate work of superior quality. The majority of these appointments go to candidates for the doctor's degree, but each year a number of places are assigned to beginning graduate students of extraordinary promise. Further information and application forms may be obtained from F. H. Finch, 105 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: B. L. Dodds (Dean of the College of Education), C. M. Allen, A. W. Anderson, T. E. Benner, G. M. Blair, R. B. Browne, R. W. Burnett, A. W. Clevenger, F. G. Cornell, L. J. Cronbach, J. J. DeBoer, G. P. Deyoe, E. W. Dolch, F. H. Finch, C. R. Griffith, H. M. Hamlin, H. C. Hand, J. T. Hastings, K. B. Henderson, W. V. Kaulfers, S. A. Kirk, W. P. McLure, P. V. Miller, C. W. Odell, M. M. Ohlsen, E. F. Potthoff, E. H. Reeder, C. W. Sanford, H. A. Schultz, J. H. Shores,

R. H. Simpson, B. O. Smith, Celia B. Stendler, M. R. Sumption, J. L. Trump, Letitia E. Walsh.

Associate Professors: D. P. Ausubel, F. P. Barnes, R. N. Evans, G. C. Finlay, N. L. Gage, W. E. Harnish, M. Horwitz, M. R. Karnes, G. C. Kettelkamp, C. G. Knapp, W. M. Lifton, W. E. Martin, F. McMurray, T. E. Newland, L. J. Phipps, R. E. Pingry, W. O. Stanley, H. S. Zim.

Assistant Professors: G. F. Anderson, Ann E. Jewett, R. S. Jones, O. P. Kolstoe, D. R. Krathwohl, A. H. Krebs, L. E. Metcalf, G. W. Sowards.

COURSES FOR GRADUATES

400. **Ancient and Medieval Education.** A study of educational thought and practice in early Mediterranean civilizations, in ancient Greece and Rome, and in the Middle Ages. Emphasis is placed on the relation of education to the intellectual and social conditions of the several periods covered. I; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Education 300 or consent of instructor. Anderson.

401. **Modern Theories of Education.** A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. II; 1 unit. Stanley.

402. **Educational Movements in the Twentieth Century.** An historical study of the more significant educational trends during the past fifty years with special reference to their influence on the problems of American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and an examination of the efforts to solve the problems since 1900. I; 1 unit. Prerequisite: Education 300, or 302, or 403, or consent of instructor. Anderson.

403. **The Historical Foundations of American Educational Thought.** A study of the evolution of education theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. II; 1 unit. Prerequisite: Education 300 or 302, or consent of instructor. Anderson.

404. **Seminar in Educational Classics.** Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. II; 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor.

405. **Foundations of Group Method.** A critical study of the ethical, social-psychological, and methodological ideas and problems underlying currently proposed methods for the management and improvement of groups and for training leadership in using these methods, with special attention to the use of such methods in educational settings. The work includes student projects in the management and improvement of educational and action groups. I; 1 unit. Prerequisite: Education 311 and 312; two of the following: Education 301, 302, 303, 304. Miller.

406. **Seminar in the History of Education.** Intensive group study of a small number of selected problems to assist individual students to develop under-

standing of and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. II; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. ANDERSON.

407. **Logical Foundations of Methods.** A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment, and knowing, examined from the standpoint of recent developments in pragmatism. II; 1 unit. Prerequisite: Consent of instructor. MCMURRAY.

408. **Advanced Philosophy of Education.** A rigorous examination of the foundations of educational theory as they relate to the major educational issues of our time. This examination requires a careful analysis of the pertinent works of John Dewey, as well as the more significant current philosophical viewpoints opposed to Dewey's outlook. I; 1 unit. Prerequisite: Advanced graduate standing; consent of instructor. MCMURRAY, STANLEY.

409. **Advanced Philosophy of Education.** Continuation of Education 408. II; 1 unit. Prerequisite: Education 408. MCMURRAY, STANLEY.

410. **Seminar in Theories of Educational and Social Change.** Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. I; 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in Education. SMITH, STANLEY.

411. **Psychology of Adolescence for Teachers.** The psychological significance of adolescence, its biological and social foundation, and its implications for education. I, II; 1 unit. Prerequisite: Education 311 and 312. AUSUBEL, BLAIR.

412. **Advanced Child Development for Students of Education.** A consideration of the nature of the child and his development during the pre-school and elementary school years, with emphasis on development as a process of social learning; an interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. I, II; 1 unit. Prerequisite: Education 311 and 312. AUSUBEL, MARTIN, STENDLER.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. II; 1 unit. Prerequisite: Education 311 and 312. GAGE.

414. **The Psychology of College Teaching.** Designed particularly for graduate students minoring in education or preparing for college teaching. This course is concerned with psycho-educational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, adjustment problems of college students, counseling and advisory services, test construction analysis, and use of test results and resource materials in this field. I; 1 unit. SIMPSON.

415. **Psychological Theories Applied to Education.** An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. I, II; 1 unit. Prerequisite: Education 311 and 312; Education 411 or 412; candidacy for Ed.D. or Ph.D. in Education. Blair.

416. **Problems in Mental Deficiency.** An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis, and social, medical, psychological, and educational rehabilitation procedures. The emphasis of the course is on the contributions of biology, sociology, anthropology, and psychology to educational theory and practice with reference to the mentally deficient. I; 1 unit. Prerequisite: Education 322 or 323, or consent of instructor. Kirk.

417. **Psycho-educational Problems of Exceptional Children.** A course for teachers, elementary school supervisors, principals, and superintendents, and for supervisors of special education programs. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children, consideration of the special school provisions needed for their education and development, including the social and educational backgrounds of special education programs, the problems of selection of children for special education, teaching procedures, buildings and equipment needed in the programs, legal bases for such programs, financing, and administration. I, II; 1 unit. Prerequisite: Sixteen hours of psychology and/or education, or consent of instructor. Kirk, Newland.

418. **Problems in Communication for the Deaf.** An advanced course in the problems of communications used by the deaf, including the learning of language, reading, speech, and speech reading. Consideration is given to the various methods that are used in the teaching of these basic skills to deaf children and the psychological principles underlying the methods. II; 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Education 319 and 320, or equivalent.

419. **Clinical Educational Diagnosis.** A clinical course in the diagnosis of educational disabilities, including reading, spelling, and arithmetic. Practice in the use of diagnostic instruments, interpretation of results, and case studies, with recommended remediation, are emphasized. II; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Education 311 and 312; Psychology 443. Kirk.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, the effects of different handicaps on adjustment to different situations; the somatopsychological significance of mental, sensory, and motor variations in the adjustive process; the effects of limitations imposed on different groups of handicapped children and adults by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. The implications of somatopsychological findings and theories for current educational programs for the handicapped are analyzed. II; 1 unit. Prerequisite: Education 117 and 312. Newland.

422. **Basic Principles of Counseling.** Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. I, II; 1 unit. Prerequisite: Education 311 and 312. Lifton, Proff.

423. **The Use of Tests in Guidance.** Deals with purposes of types of tests used in studying guidance problems, the principles underlying the choice, and

critical analysis of tests of ability and personality that are useful in this area, and the problems that occur in the collection of test data for school guidance programs. I; 1 unit. CRONBACH, GAGE, HASTINGS.

424. **Case Analysis in Guidance.** The nature, synthesis, and use of case data for guidance purposes. Students will develop skills in solving typical counseling problems as they experience them through role playing and other laboratory experiences. II; 1 unit. Prerequisite: Education 422 and 423; consent of instructor. LIFTON, PROFF.

425. **Principles of Guidance.** For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the relationship of guidance specialists, and the guidance functions of community agencies. Students who have taken Education 325 are not allowed credit for Education 425. I, II; 1 unit. ANDERSON, FINCH, LIFTON, OHLSEN.

426. **Diagnostic and Remedial Programs of the School.** A study of remedial programs in personality, reading, spelling, English, arithmetic, handwriting, and content subjects. I, II; 1 unit.

427. **Principles and Techniques of Group Guidance.** A study of the principles of group guidance and their application in educational settings. The course includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. S; 1 unit. Prerequisite: Education 311, 312, 422, 423, 325 or 425, or consent of instructor. LIFTON, OHLSEN.

428. **The Analysis and Use of Occupational Information in Guidance Programs.** This course covers the study of the individual in relation to jobs, sources of occupational information, the organization of vocational information for use in guidance and counseling, and research techniques to be applied in local occupational studies. I; 1 unit. Prerequisite: Education 325, 425, or consent of instructor. OHLSEN.

430. **Elementary School Organization and Administration.** This course is intended primarily for elementary school principals and for those who are preparing for the principalship. Such topics as the following are considered: present status of the elementary school principal; classification and promotion of pupils; school records; report cards; plans for student participation in self-government; and school-community relationships. I; 1 unit. Prerequisite: Education 431 and 439. BARNES.

431. **Elementary School Classroom Programs.** An exploration of several organizational centers for determining selection and sequence of educative experiences: the social problems approach, the themes approach, the centers of interest approach, and the life situations approach. The role of the teacher in relation to the above considerations is emphasized. I, II; 1 unit. MOORE, SOWARDS, STENDLER.

432. **Advanced Problems in Elementary School Teaching.** A study of and research in the problems of designing and programming experiences for children at the various levels of the elementary school: concentration on the place of skills, group interrelations, social understandings, health problems, creative activities, and the like. Course is based on specific needs and problems of individual students enrolled. I; 1 unit. Prerequisite: Education 431 and 439. SHORES.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in

the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections will usually be offered in the fields of reading and the language arts, social studies, elementary science, and arithmetic. I, II; 1 unit. Prerequisite: Education 431; for the section in reading and the language arts, Education 336, or a course in the teaching of reading or language arts, or consent of instructor; for the section in elementary science, Education 335 and two years of college science, or consent of instructor. MARTIN, REEDER, SHORES, ZIM.

436. **Social and Psychological Factors in Elementary School Curriculum Development.** Intended to enable curriculum workers to design and to deal effectively with the specific problems involved in changing curriculum structures and content. I; 1 unit. Prerequisite: Education 412, 431, and 439. BARNES, SHORES.

437. **Methods of Child Study.** A study of ways in which teachers can evaluate child behavior and development. Demonstration, observation, practice. II; 1 unit. Prerequisite: Education 311, 312, and 412. MARTIN.

438. **Supervision of the Elementary School.** Designed for present and prospective supervisors in elementary schools. It considers the purposes of supervision in the context of a democratic theory of teaching and learning. The use of teachers' meetings and of individual supervisory techniques are given special attention. II; 1 unit. Prerequisite: Education 431 and 439. REEDER.

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. I, II; 1 unit. SHORES, SMITH.

440. **Administration and Supervision of Junior and Senior High Schools.** Discussion of practical problems; functions of the principal; teacher participation; personnel records, marks, failures, and promotions; administration and supervision of the curriculum, of guidance programs, of extracurricular activities, and of housing and building programs. I, II; 1 unit. Prerequisite: Education 460 or consent of instructor. TRUMP.

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. II; 1 unit. CLEVENGER.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. I, II; ½ to 1 unit. No more than two units in Education 449 may be offered toward an advanced degree except by special consent of the Dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. Next steps needed for progress in appraisal. II; 1 unit. WALSH.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics;

organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. I; 1 unit. WALSH.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. II; 1 unit. WALSH.

456. **Curriculum Problems and Trends in Specialized Fields of Secondary Education.** Sections usually offered in the fields of art education, business education, English, home economics, mathematics, foreign langauges, science, social studies, common learnings. Designed to develop an understanding of the function of a specific field of special interest in general education. The course applies principles of curriculum construction to the special field. It introduces the student to significant problems, points of view, and trends in the field concerned. It also acquaints him with significant research relating to organization, content, and techniques in the fields in question. Students are limited to registration in any two sections in addition to the section on common learnings. I, II; 1 unit. Prerequisite: Education 439 or consent of instructor. BURNETT, DEBOER, HAND, HENDERSON, KAULFERS, KNAPP, METCALF, SCHULTZ, WALSH.

457. **Supervision of Student Teaching.** The organization and operation of student teaching programs. Individual investigation of content, experiences, theory, and practice for those who plan to supervise student teaching activities. I; 1 unit. Offered in 1954-1955 and in alternate years.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of business, English, home economics, physical education, mathematics, science, social studies, and common learnings education. Broader areas of emphasis, within which students may work, are extra-class activities, conservation, consumer education, family living, guidance, health, inter-group relations, labor-management relations, and public opinion and propaganda. S; 1 to 2 units. STAFF.

460. **Educational Administration.** Provides the basic common understanding of theory and practice in American educational administration which should be expected of teachers, supervisors, and administrative officers. Not open to students who have taken any of the following courses: Education 461, 462, 464, 465, 466. I, II; 1 unit. BENNER, CLEVENGER, MILLER.

461. **School Finance.** Designed for advanced graduate study of technical problems in school finance. A critical analysis of emerging patterns of financial support in various states, effect of taxation systems on support patterns, emerging controls and structural features as related to finance, the technology of finance distribution patterns for drafting legislation. Review of research on school finance, a critical analysis of theory of school finance, and introduction to techniques of appraising the influence of financial support upon educational returns. I; 1 unit. Prerequisite: Education 460. MCLURE.

462. **Public School Business Management.** Designed for advanced graduate study of business management of local school systems. Emphasis is on the process of operation through first-hand acquaintance with budget making and execution; management of internal accounts; development of effective record systems; purchase, distribution, and management of supplies; operation and maintenance of school plants; management of auxiliary services such as transportation, cafeterias, health; and general office management. II; 1 unit. Prerequisite: Education 460. MCLURE, MILLER.

464. **Current Problems in School Administration.** Practicum in school administration for administrators in service. The course is designed to give direct

help on local problems, to serve as a refresher course, and to bring the administrator up to date on recent developments in school administration. Open only to students currently employed as school administrators. S; 1 to 2 units. STAFF.

465. **Public School Finance and Business Administration.** The theory and practice of financing public education in the United States; development of guiding principles in educational finance, trends and needs in state and federal participation in school support, and local operational finance. II; 1 unit. Prerequisite: Education 460; experience in teaching or administration. Not open to students who have completed Education 461 or 462. MCLURE, MILLER.

466. **Administrative Leadership.** This course considers the generalized procedures (based on principles underlying democratic leadership drawn from philosophy, psychology, and sociology) by which the administrator may work with and through people to develop and operate effective educational programs in public school systems. II; 1 unit. Prerequisite: Education 405 and 460. MILLER.

467. **The American College.** Development of the American college and university, public and private, conflicting theories; present trends. II; 1 unit. BENNER.

468. **Public Relations of the Schools.** Study of the interrelationships between the lay community and the schools; appraisal of procedures, actual or proposed, for the improvement of these relationships. I; 1 unit. BENNER.

469. **Legal Basis of School Administration.** The legal rights, privileges, responsibilities, immunities, and authority of pupils, parents, teachers, administrators, and school board members in relation to the school. I; 1 unit. SUMPTION.

471. **Public School Education in Agriculture: Policies and Programs.** Local policies and policy making, organizing agricultural education in a public school system, planning and evaluating programs of agricultural education, lay and professional roles in policy making and program planning, department organization and management, facilities for a modern program of agricultural education. I; ½ unit. Prerequisite: Education 276 and 277. Open to school administrators without prerequisites. HAMLIN.

472. **Agricultural Education in Secondary Schools.** Place of agricultural education in secondary schools; functions of vocational and non-vocational agriculture; coordination of class work; supervised farming; the F.F.A.; guidance; course planning; teaching procedures and aids; facilities. I; ½ unit. Prerequisite: Education 276 and 277. DEYOE.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, adult education in the public schools, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, organizing adult classes, course planning, teaching procedures and aids, supervised practice, group activities, facilities. II; ½ unit. Prerequisite: Education 276 and 277. HAMLIN.

474. **Supervised Farming in Vocational Agriculture.** Importance and meaning of supervised farming; evaluation of supervised farming; relation to establishment in farming; selecting and planning farming programs; records; related instruction; supervision; nature of supervised farming for students in day-school, young farmers, and adult farmers classes. II; ½ unit. Prerequisite: Education 276 and 277. DEYOE.

476. **Guidance in Agricultural Education.** The guidance function in high school, young farmers and adult farmers classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation

of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment in farming, placement, follow-up. S; ½ unit. Prerequisite: Education 276 and 277.

477. **Field Studies in Agricultural Education.** Planning and introducing new policies, programs, and projects in agricultural education into the schools in which the students are employed. Open to students with at least one year of experience in teaching non-collegiate agriculture who are teaching in Illinois and to Illinois school administrators. I, II; 1 unit. Prerequisite: Agricultural Education 276 and 277. Open to school administrators without prerequisites.

479. **Education of Teachers of Agriculture.** Critical review of teacher-education programs in operation; recruiting, guidance, and selection of trainees; objectives; evaluation; curricula and courses, student teaching; in-service training; facilities, administration; financing; selection and training of the teacher-education staff. II; ½ unit. Prerequisite: Two graduate courses in agricultural education.

481. **History and Fundamental Concepts of Vocational Education.** A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. I; 1 unit. Karnes.

482. **Research Studies in Industrial Education.** Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student will propose and complete a brief research, or plan in detail a major research project to be completed later. II; 1 unit. Evans, Karnes.

487. **Seminar in Industrial Education.** I; 1 unit. Evans.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses. Study of basic concepts underlying course construction in industrial education. I; 1 unit. Prerequisite: Undergraduate work in industrial education. Evans, Karnes.

489. **Administration and Supervision of Industrial Education.** Problems and approved practices in the administration and supervision of programs of industrial education in the secondary schools. II; 1 unit. Prerequisite: Undergraduate work in industrial education. Karnes.

490. **Seminar for Advanced Students of Education.** Open only to persons who have been admitted to candidacy for the degrees of Ph.D. or Ed.D. Sections of this seminar will usually be offered in the following areas: philosophical and social foundations of education, psychological foundations of education, elementary education, secondary education, educational administration, guidance and counseling, education of the exceptional child, industrial arts and vocational education, agricultural education, and home economics education. I, II; 1 to 2 units. Staff.

491. **Thesis.** Individual direction in research and guidance in writing theses for advanced degrees. I; ½ to 4 units. Staff.

492. **Thesis.** Individual direction in research and guidance in writing theses for advanced degrees. II; ½ to 4 units. Staff.

495. **Theory of Measurement in Education.** The principal theories of test construction and design, psychophysical and psychometric methods of measurement, the criterion problem and techniques of validation, test reliability theory, the theory of measurement as it functions in modern conceptions of educational practice, and the appraisal of educational programs. I; 1 unit. Prerequisite: Education 496; Education 423 or 498. Cronbach, Hastings, Krathwohl.

496. **Statistical Methods in Education.** First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and the testing of statistical hypotheses; and other applications of statistics to educational research. I; 1 unit. Prerequisite: Education 390. CORNELL, KRATHWOHL.

497. **Advanced Statistical Methods in Education.** An advanced course in statistical methods applied to educational research. Statistical estimation, analysis of variance and co-variance, statistical design of experiments, introduction to factor analysis, the use of mathematical models in educational theory. II; 1 unit. Prerequisite: Education 496. CORNELL.

498. **Theory of Educational Evaluation.** Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design. Emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. II; 1 unit. Prerequisite: Education 496. HASTINGS, KRATHWOHL.

499. **Field Study and Thesis Seminar.** This seminar is usually required of candidates for the degree of Doctor of Education who are taking major work in one of the following areas: philosophical and social foundations of education, secondary psychological foundations of education, elementary education, secondary education, educational administration, guidance and counseling, education of the exceptional child, industrial arts and vocational education, agricultural education, and home economics education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation; tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. I, II; 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **The History of Education.** Brief, introductory summary of ancient and medieval education followed by a more extended study of educational developments since the Italian Rennaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. I, II; ½ unit. ANDERSON.

301. **Philosophy of Education.** Based on a careful and critical reading of selected chapters from John Dewey's *Democracy and Education.* Designed to develop competencies in locating and criticizing basic assumptions of an educational argument, in examining and criticizing basic assumptions about educational purposes and practices, and in examining and testing systematic relationships between educational ideas and assumptions, etc. I, II; ½ unit. MCMURRAY, SMITH, STANLEY.

302. **History of American Education.** The development of theory and practice in American education in relation to political, social, and cultural developments. I, II; ½ unit. ANDERSON.

303. **Comparative Education.** General foundations course designed to contribute to professional competence in dealing with those educational problems requiring an understanding of the relationship of education to a particular

society. A study of selected national systems of education in their differing cultural settings. I, II; ½ unit. KAULFERS.

304. **Social Foundations of Education.** An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. Designed to develop competencies in understanding of the role of the culture in shaping both human personality and social institutions, evaluating the effects of the various welfare and class levels in the United States on the lives of children and adults and on the work of the school, and understanding major elements operating in the social crisis of our time and the impact of these elements on education. I, II; ½ unit. SMITH, STANLEY.

311. **Psychology of Learning for Teachers.** A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understandings. I, II; ½ unit. Prerequisite: Education 211 and practice teaching or teaching experience. BLAIR, CRONBACH, GRIFFITH, GRONLUND, JONES, POTTHOFF, SIMPSON.

312. **Mental Hygiene and the School.** A consideration of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. I, II; ½ unit. Prerequisite: Education 211 and practice teaching or teaching experience. BLAIR, GRIFFITH, GRONLUND, JONES, HORWITZ, POTTHOFF, SIMPSON.

315. **Sociology of Education.** Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. I or II; ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. SHIDELER.

318. **Workshop and Laboratory in Education of Exceptional Children.** Observation of special laboratory classes of various types of exceptional children; group discussions; conferences with specialists as consultants; work on a project of particular concern to the individual student. S; 1 unit for four weeks; 2 units for eight weeks. Prerequisite: Senior standing.

319. **Special Education of the Deaf.** Survey of the curriculum and techniques in pre-schools, kindergarten, and primary and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child. A study of sense training, lip reading, vocabulary development, reading techniques, language and speech development, auditory training, and curriculum construction. I; 1 to 1½ units. Prerequisite: First three years of curriculum for teachers of the deaf, or equivalent.

320. **Special Education of the Deaf.** Continuation of Education 319. II; 1 to 2 units. Prerequisite: Education 319.

321. **Care and Education of Orthopedically Handicapped Children.** Survey of orthopedic handicaps in children, psychological and social effects of such handicaps, and the kinds of schools and services provided for the education of the various types of crippled children. The education of the cerebral palsied child is emphasized. S; 1 unit. Prerequisite: A teacher's certificate, or senior standing, or a major in some area of special education.

322. **Psychology and Education of the Mentally Handicapped.** A study of the social, emotional, physical, and learning characteristics of mentally handicapped children; methods of diagnosis and differentiation; educational organization and teaching techniques employed for their rehabilitation. I; ½ unit. Prerequisite: Education 231; senior standing. KIRK.

23. **Psychology and Education of the Mentally Handicapped.** Continuation of Education 322, with emphasis on curriculum. II; ½ unit. Prerequisite: Education 322. Kirk.

24. **Mental and Educational Measurement of Exceptional Children.** Designed to develop an understanding of and ability to interpret the results of psychological and educational tests. Practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing acoustically handicapped, orthopedically handicapped, visually handicapped, mentally handicapped, and defective of speech. II; ½ unit. Prerequisite: Education 117 or consent of instructor. Kirk, Newland.

25. **Introduction to Guidance and Counseling.** Basic concepts and practices of guidance in public schools; what the teacher can do in guidance. Students may not register for credit in both Education 325 and 425. I, II; ½ unit. Prerequisite: Senior standing; eight hours in education and psychology. Finch, Ohlsen.

35. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the classroom teacher and the specialist. Opportunity for experience in field and laboratory work. I, II; ½ unit. Prerequisite: Education 101 and 201, or equivalent; two years of college science. Zim.

36. **Primary Reading.** Critical evaluation of current schools of thought with regard to the teaching of reading and an analysis of the concept of learning as well as the meaning of reading upon which each school is based. Attention is given to reading as a part of the total growth process of the child and to knowledge of methods and materials used in teaching beginning reading. I, II; ½ unit. Prerequisite: Education 101, 201, and 230. Moore, Stendler.

37. **Art Education in the Elementary School.** Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. I, II; ½ unit. Prerequisite: Education 101, 201, and 230. Schultz.

54. **Audio-Visual Materials and Problems.** Audio-visual materials are examined from the point of view of their effectiveness and possible utilization in the school program. Recent investigations on materials and methods of presentation are studied to ascertain their pedagogical implications. The technical and administrative problems of integrating audio-visuals into the school curriculum are considered. I, II; ½ unit. Prerequisite: Education 211, 231, or 241; senior standing. Peterson.

70. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meetings in August and November; other meetings in centers in the state convenient to first-year teachers. Visits by instructor to schools in which first-year teachers are employed. I; ½ unit. Prequisite: Education 276 and 277. Phipps.

81. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. I, II; ½ to 1 unit. Humble.

82. **Organization and Administration of Diversified Occupations Programs.** The course is designed to provide the specific professional training required of teachers and coordinators who are to conduct programs of diversified occupations in the secondary schools. II; ½ to 1 unit. Karnes.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. II; ½ to 1 unit. HUMBLE, KARNES.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. Prerequisite: Sixteen hours in industrial education. I, II; 1 unit. HUMBLE, TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, together with their relationships to other educational agencies. II; 1 unit. EVANS.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations are utilized. I, II; 1 unit. Prerequisite: Junior standing; ten hours of undergraduate credit in industrial education. EVANS, HUMBLE, KARNES.

390. **Elements of Educational Statistics.** Designed for terminal value for professional training of students not intending to pursue advanced graduate work, and for introductory value for students continuing graduate study in education. The course includes descriptive statistics, the nature of measurement in education, introduction to regression, correlation analysis, statistical inference, and the presentation and interpretation of statistical data in educational literature. I, II; 1 unit. ODELL.

391. **Introduction to Evaluation.** This course is designed to serve two chief purposes: introduction to the broad field of evaluation, particularly its relation to curriculum development, and training in constructing tests in school subjects. It gives brief attention to intelligence, personality, and other measurement; types of scores; marking systems; selecting standard tests; testing programs; uses of results of measurement. I, II; 1 unit. HASTINGS, KRATHWOHL, ODELL, SIMPSON.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the degree of Master of Science in Electrical Engineering and Doctor of Philosophy in Engineering is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois in the option in which advanced work is desired. The fields of specialization are physical electronics and electronic engineering, illumination, and power engineering. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. An applicant's undergraduate grade-point average must be at least 3.75 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students on limited status will not be admitted to graduate work in this department.

Courses for advanced undergraduates and graduates are also open for credit to students with a major in other departments, who have the proper prerequisites.

The objectives of a well-rounded graduate program in electrical engineering may be classified as follows:

(1) The development of a more thorough understanding of the basic fundamentals of electrical engineering.

(2) Development of better tools for the solution of electrical engineering roblems.

(3) Uncovering of special characteristics of initiative and resourcefulness.

(4) Development of a specialist's understanding in some area of the electrical ngineering field.

To help determine his program, each student takes a written advisory examination in electrical engineering to determine the extent of his background. This xamination is diagnostic in character, and the results are expected to provide ıggestions for further study, either formal or informal. With the help of the dvisory examination, a faculty adviser is appointed for each entering graduate udent. The adviser and the student together work out the program which the udent is to follow.

Students specializing in communications and electronics and in power engieering will be required to complete Electrical Engineering 416 and 418, or ırnish evidence of equivalent training. It is also expected that the student will nroll in such additional mathematics work as a review of his training and the eld in which he specialized would indicate advisable. Advanced courses in mathmatics, physics, chemistry, mechanics, and in other branches of engineering are ıggested as suitable minor subjects. A minor sequence in physics to include hysics 381 and 362 is recommended.

Physical Electronics and Electronic Engineering. It is recommended that raduate students specializing in this field acquire a general knowledge of the hole field as well as a specialized knowledge of some part of it. Therefore, it is ıggested that Electrical Engineering 414, 420, 422, and 423 be taken as early in ıe program as possible.

For graduate work in communication and electronics, the student should offer ıe equivalent of the following undergraduate courses: Electrical Engineering 30, 331, 332, and 333, Electrical Machinery; 341 and 349, Electronics; 351, etworks and Lines; 353 and 355, Communication Engineering; and Differential quations. Students with deficiencies must satisfy these requirements.

Illumination Engineering. The courses in illumination are designed to proide an analytic basis for illumination engineering, rather than to develop the ıeory of light and photometry. Mathematical analysis is applied to illumination esign and the answers are compared with the results found in practice.

It is suggested that Electrical Engineering 460 and 461 be taken as early in ıe program as possible and that the student also include vector analysis during ıe course of his work. Research work may be in the theory and practice of luminating engineering or colorimetry.

For graduate work in illumination, the student should offer the equivalent of ıe following undergraduate courses: Electrical Engineering 320, 321, 322, and 23, Circuit Analysis; 330, 331, 332, and 333, Electrical Machinery; 341, Elecronics; 268, Illumination; and Differential Equations.

It is expected that the student will have some preparation in light, physilogy, and psychology. Students with deficiencies must satisfy these requirements.

Power Engineering. Graduate work in the power option falls naturally into ıe fields of circuits, machinery, and power systems. To provide a suitably broad ase and assure adequate preparation for the courses to follow, it is suggested that lectrical Engineering 414, 440, 442, and 444 be taken as early in the program s possible.

For graduate work in power, a student should offer the equivalent of the ollowing undergraduate courses: Electrical Engineering 334, 335, 336, 337, 338, 39, Electrical Power Apparatus; 341, Electronics; and Differential Equations. tudents with deficiencies must satisfy these requirements.

The courses listed below indicate by their content the general field to which ıey belong. It is recognized that the candidate for the master's degree would not

take all of the courses in a particular field, while a candidate for the doctor's degree might expand the listing through a study of special problems. To add broadness as well as depth to his program, a student should include some courses which are not in his chosen option.

FELLOWSHIPS

The Galvin Fellowship is offered annually by Motorola, Inc., of Chicago, to a graduate student in electrical engineering majoring in the field of radio engineering. It is awarded with a stipend of $1,200 on recommendation of the Department of Electrical Engineering.

One fellowship is offered annually by the Westinghouse Educational Foundation, Pittsburgh, Pennsylvania, to a graduate student in electrical engineering. It is awarded with a stipend of $1,200 upon recommendation of the Department of Electrical Engineering.

Other industrial fellowships are available from time to time.

The Central Illinois Section of the American Institute of Electrical Engineers annually offers awards totaling $25 for the best papers submitted by graduate students in electrical engineering in a competition usually held in the spring of the year.

GRADUATE TEACHING FACULTY

Professors: E. C. Jordan (Head of Department), J. Bardeen, W. L. Emery, W. L. Everitt, M. A. Faucett, G. H. Fett, L. Goldstein, H. N. Hayward, M. S. Helm, V. P. Hessler, C. A. Keener, A. R. Knight, J. O. Kraehenbuehl, M. B. Reed, E. A. Reid, V. H. Rumsey, H. M. vonFoerster, N. Wax.

Associate Professors: G. E. Anner, L. B. Archer, A. D. Bailey, P. D. Coleman, W. J. Fry, F. E. Hohn, H. W. Horn, W. E. Miller, T. A. Murrell, P. F. Schwarzlose, C. E. Skroder, R. M. Wainwright, H. D. Webb, E. K. Weise.

Assistant Professors: C. E. Drumheller, R. H. DuHamel, H. E. Koenig, J. E. Robertson, E. W. Schwarz.

COURSES FOR GRADUATES

400. **Seminar.** Required of all graduate students. I, II; no credit. Jordan.

410. **Engineering Analysis.** Static and dynamic field problems with emphasis on the relationships between the various branches of engineering and the development of the use of mathematics as a tool in the solution of complex problems. I, II; 1 unit. Hessler.

412. **Advanced Engineering Measurements.** Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. I, II; 1 unit. Hayward.

413. **Servomechanisms and Automatic Control Devices.** Fundamental theory of servomechanisms and other automatic control devices, electrical analogies, stability, transfer functions, and on-off mechanisms. I, II; 1 unit. Fett.

414. **Foundations of Electrical Network Theory, I.** Formulation and study of foundation axioms of electrical networks, topological basis of mesh and node methods, mesh and node equations by means of matrix transformations, and general proofs of standard network theorems. I; 1 unit. Reed.

15. **Foundations of Electrical Network Theory, II.** A detailed study of the response of lumped electrical networks by matrix transformation of the generalized mesh and node methods. II; 1 unit. Reed.

16. **Advanced Circuit Analysis.** Fundamentals of network theory and theorems, transients, Laplace transform, and the complex frequency concept. I, II; 1 unit. Reed.

18. **Electric and Magnetic Fields.** Rigorous treatment of basic laws, static fields, field systems, harmonic functions, conjugate functions, conformal transformation. I, II; 1 unit. Emery.

20. **Electromagnetic Waves and Radiating Systems.** Fundamental electromagnetic theory with applications to transmission lines, wave guides, and antennas. I, II; 1 unit. Jordan.

21. **Advanced Electromagnetic Engineering.** Cylindrical and spherical electromagnetic waves; radiation and diffraction; advanced antenna theory; ground and sky wave propagation. I, II; 1 unit. Prerequisite: Electrical Engineering 420. Jordan.

22. **Advanced Communication Networks.** Fourier integral and matrix algebra, analysis of networks, and network synthesis for wide band operation. I, II; 1 unit. Skroder.

23. **Electron and Ion Dynamics.** Laplace equation, conformal transformations, Poisson's equation with initial velocities and transit time, electron optics, and electron ballistics of klystrons and magnetrons. I, II; 1 unit. Prerequisite: Credit or registration in Electrical Engineering 420. Wax.

24. **Theory of Gaseous Discharge Devices.** Motion of ions and electrons; ionization and deionization; space charge and plasma; glow and arc discharges; circuit interruption; arc extinction problems. I, II; 1 unit. Goldstein.

25. **Photoelectric and Thermionic Phenomena.** Experimental basis for thermionics, thermoelectricity, and photoelectricity; thermodynamics of electron emission and thermoelectricity; basis of quantum statistics and application to thermionics and photoeffect. I, II; 1 unit. Murrell.

26. **Electroacoustical Systems.** A study of the solutions of differential equations of wave motion with applications to vibrating strings, membranes, rods, sonic systems, loud speakers, microphones, galvanometers. I, II; 1 unit. Fry.

27. **Boundary Value Problems.** Derivation and solution of partial differential equations and integral equations of mechanics and electricity and magnetism; study of the analysis of wave motions. I, II; 1 unit. Coleman.

28. **Nonlinear Oscillating Systems.** Criteria for stability of nonlinear oscillations; nonlinear resonance; study of analytical methods; harmonics and subharmonics, and relaxation oscillations. I, II; 1 unit.

29. **Vacuum Tube Circuit Analysis.** Vacuum tube network theory, feedback circuits and amplifiers, stability, equalizers, and relations between components of network functions. I, II; 1 unit. Fett.

30. **Gas Tube Circuit Analysis.** Equivalent circuit of gas tubes at low and high frequencies, circuit analysis, and rectifiers. II; 1 unit.

31. **Microwave Circuits.** Four-terminal networks and transmission line theory, bilinear transformations, wave guides, the generalized impedance concept, expansion of fields in normal modes, resonant cavities, and measurement techniques. I, II; 1 unit. Prerequisite: Electrical Engineering 420. Jordan.

32. **Network Synthesis — Image-Parameter Method.** A study of the image-parameter method of synthesizing a four-terminal network (filter and equalizer) which has a prescribed insertion loss. I; 1 unit. Reed.

433. **Transmission of Information.** II; 1 unit. Prerequisite: Electrical Engineering 422. Wax.

435. **Conduction of Electricity in Solids.** Same as Physics 435. Application of quantum theory of solids to conduction of electricity in metals, insulators, and semi-conductors. Emphasis is placed on fundamentals of current flow in semi-conductors to provide a background for transistor electronics. Topics covered include impurity and intrinsic semi-conductors, photo-conductivity, Hall and thermoelectric effects, theory of conductivity in solids, metal semi-conductors rectifying contacts, p-n junctions, theory and characteristics of point-contact and junction transistors. II; 1 unit. Prerequisite: Physics 381, Electrical Engineering 425, or consent of instructor. Bardeen.

436. **Applied Electrodynamics.** Tensor form of Maxwell's equations, special relativity, radiation reaction, integration of wave equations, Lagrange and Hamiltonian equations. Applications to submillimeter wave generation, Cerenkov effect, radiation from particle accelerators, electron bunching at high energies. II; 1 unit. Coleman.

440. **Advanced Power Circuit Analysis, I.** Special methods of polyphase circuit analysis, transients in multiple loop lumped constant circuits by differential equations and by Heaviside expansion theorem, and study of circuits having nonlinear parameters by step-by-step method. I, II; 1 unit. Knight.

441. **Advanced Power Circuit Analysis, II.** Transients in multiple loop lumped constant circuits by Fourier integral and by Laplace transforms, and study of steady state relations and transients in distributed constant circuits. I, II; 1 unit. Prerequisite: Electrical Engineering 440. Knight.

442. **Advanced Analysis of Alternating Current Machinery.** Steady state analysis of synchronous machines, round rotor and salient poles, magneto-motive forces with symmetrical and unsymmetrical windings, torque angle characteristics, vibration, and noise. I, II; 1 unit. Keener.

443. **Analysis of Dynamo Machines Under Transient Conditions.** Analysis of the operation of alternating and direct current machines under transient conditions, armature and field phenomena and mutual reactions of dynamo machines with system transients. I, II; 1 unit. Prerequisite: Electrical Engineering 442. Keener.

444. **Advanced Power System Analysis.** Electrical and mechanical properties of transmission systems, calculations of fault currents, power diagrams, and power limits. I, II; 1 unit. Prerequisite. Electrical Engineering 440. Faucett.

445. **Power System Transients and Stability.** Steady state power limits, criteria for loss of synchronism, effects of voltage regulation, exciters, and steady state as influenced by dynamic stability. I, II; 1 unit. Prerequisite: Electrical Engineering 444. Faucett.

446. **Electrical Design (Apparatus).** Properties of materials, field mapping, leakage fields, cooling and rating of apparatus, limitations affecting design, prediction of operating characteristics, and special design problems. I, II; 1 unit. Archer.

447. **Electrical Design (Power System).** Sources of energy, location of generating stations, selection of units, location of transmission lines, layouts of systems, and extension of established systems. I, II; 1 unit. Faucett.

460. **Treatment of Experimental Illumination Data.** Representation of data by tables, graphs, and equations, tabular and graphical differentiation and integration, normal frequency distribution, measure of averages, variability and relationship, indexes and adjustment of measurements. Methods applied to

observations made with both light and illumination as part of human environment. I, II; 1 unit. KRAEHENBUEHL.

161. **Methods of Illumination Calculations.** Fundamentals of the light field, illumination in space, the light vector, plots of fields, and applications of light fields to engineering problems. I, II; 1 or 2 units. KRAEHENBUEHL.

162. **Colorimetry in Illumination.** Color vision, color of sources, surfaces and filters, direct measurements of spectral distributions, methods of computing tristimulus values and chromaticity coefficients, color temperature, color systems and their interrelation, linear and homogeneous transformation, color discrimination, and harmony and applications. I, II; 1 unit. KRAEHENBUEHL.

163. **Advanced Illumination Sources.** Theory of incandescent and luminescent sources of illumination; radiation characteristics of ultra-violet and infra-red phosphors. Colorimetric specifications of sources; line spectra of gas discharges. Minimum perceptible color differences as applied to the I.C.I. chromaticity diagram. I, II; 1 or 2 units. MILLER.

164. **Advanced Illumination Design.** Design of lighting equipment for both utility and comfort, control of glare through proper brightness contrasts, design for special applications, and design of floodlighting and streetlighting equipment. I, II; 1 or 2 units. HORN.

191. **Thesis.** I; ¼ to 4 units. STAFF.

192. **Thesis.** II; ¼ to 4 units. STAFF.

193. **Research.** I; ½ to 4 units. STAFF.

194. **Research.** II; ½ to 4 units. STAFF.

197. **Electrical Engineering Problems.** Special electrical engineering problems. I; ½ to 2 units. STAFF.

198. **Electrical Engineering Problems.** Special electrical engineering problems. II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

320. **Circuit Analysis.** Detailed and analytical solution of periodic current circuits; networks and network theorems; coupled circuits. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 126; Physics 108; credit or registration in Mathematics 341 or 342 or 343 or 345 and Electrical Engineering 321.

321. **Circuit Laboratory.** To accompany Electrical Engineering 320. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 320.

322. **Circuit Analysis.** Continuation of Electrical Engineering 320. Wave analysis; three-phase circuits; three-phase power and energy measurements; symmetrical components analysis; filters; transients. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 323.

323. **Circuit Laboratory.** To accompany Electrical Engineering 322. I, II; 0 to ¼ unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 322.

327. **Theory of Measurements.** Precise measurement of electrical quantities and the application of measurement theory to engineering problems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322.

330. **Electrical Machinery.** Transformers and polyphase induction motors. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 322 and 323; credit or registration in Electrical Engineering 331.

331. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 330. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 330.

332. **Electrical Machinery.** Synchronous machines, single-phase motors, direct-current machines, application. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 330 and 331; credit or registration in Electrical Engineering 333.

333. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 332. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

334. **Electrical Power Apparatus.** Single and three-phase transformers. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 322 and 335.

335. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 334. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 334.

336. **Electrical Power Apparatus.** Synchronous and induction generators and motors. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 334 and 335; credit or registration in Electrical Engineering 337.

337. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 336. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 336.

338. **Electrical Power Apparatus.** Direct-current generators and motors, converters, single-phase motors, frequency changers, duty cycles. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 336 and 337; credit or registration in Electrical Engineering 339.

339. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 338. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 338.

341. **Electronics.** High-vacuum electron tubes, emission, electron ballistics, tube characteristics, equivalent circuits, linear amplifier circuits and characteristics, gas tubes, phototubes. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321.

349. **Electron Tube Circuits.** Linear and nonlinear amplifiers, fundamentals of modulation and detection, oscillators, rectifiers. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322, 323, and 341; credit or registration in Electrical Engineering 353.

351. **Networks and Lines.** Reactance networks, general transmission line equations, low-loss lines, reflections. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 322.

353. **Radio Circuits.** Impedance transformation, reactance networks as applied to radio frequencies; principles of receivers and transmitters. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322, 341, and 351; credit or registration in Electrical Engineering 349.

355. **Fields and Waves.** Theory of VHF and microwave generators; electromagnetic fields, radiation and propagation of electromagnetic energy, radiating systems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 349.

361. **Elements of Illuminating Engineering Design.** Application of the fundamentals of optics and light to developments in the design of illumination equipment and lighting installations. I, II; 0 to ½ unit. Prerequisite: Mathematics 143; Physics 108; Electrical Engineering 260.

362. **Principles of Illuminating Engineering.** Concept and units in light calculations; calculation of illumination from point, line, and surface sources; inter-

pretation of photometric and test data. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 260; credit or registration in Electrical Engineering 363; Mathematics 345; Physics 270.

363. **Illumination and Photometry Laboratory.** Photometry and illumination measurements. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 362.

364. **Illumination Design and Economics.** Design of lighting systems for natural and artificial illumination; applications for interiors and exteriors in both commercial and industrial installations; economic studies; design of reflectors and lighting equipment. II; 0 to ¾ unit. Prerequisite: Electrical Engineering 362 and 363; credit or registration in Electrical Engineering 365.

365. **Illumination Design Laboratory.** To accompany Electrical Engineering 364. Checking and constructing equipment and installation designs in lighting. II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 364.

366. **Illumination Sources.** Study of natural and artificial light sources covering combustion, incandescent, and gaseous lamps, with emphasis on fundamental laws; radiation measurements and colorimetry. II; 0 to ½ unit. Prerequisite: Credit or registration in Electrical Engineering 364 and 365.

376. **Power Circuit Analysis.** Advanced analysis of circuits used for power transmission and distribution. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322 and 323.

378. **Fundamentals of Power Transmission Engineering.** Fundamentals of electrical and mechanical design of power transmission systems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 334.

379. **Power Transmission.** Advanced analysis of electrical power transmission systems, faults, stability. II; 0 to ¾ unit. Prerequisite: Electrical Engineering 336, 337, and 378.

380. **Illuminating Engineering.** A second course in illumination, covering units, sources, point and surface illumination, design, and economics. I; 0 to ½ unit.

381. **Pulse Techniques.** Response of electrical systems to repeated transients. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 341.

384. **Logical Design of Automatic Digital Computer Circuits.** Same as Mathematics 384. A course in the design of automatic digital computers. Major emphasis on logical structure of components and the interrelations necessary for automatic operation. I, II; 1 unit. Prerequisite: Senior standing or consent of instructor.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. II; 0 to 1 unit. Prerequisite: Consent of instructor.

387. **Electrical Design.** Fundamental principles of electrical power apparatus design with particular application to transformers and generators. Properties of materials in common use; construction of coils; magnetic attraction; stored energy; field mapping; heat dissipation; temperature rise and rating of apparatus. For students selecting the option in power. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 332 and 333, or registration in Electrical Engineering 334 and 335.

389. **Communication Design.** Design, construction, and complete test of a radio transmitter or receiver. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 349 and 353.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric)

The Department of English offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Students who enter graduate work with English as their major subject must have attained a grade-point average of 3.75 or higher during the latter half of their undergraduate work. All students must present the equivalent of fourteen hours of undergraduate work in English or American literature, and the required college work in rhetoric. They should present the equivalent of four semesters of college work in Latin, Greek, French, or German. (Four semesters of college Spanish will be accepted from candidates for the Master of Arts in the Teaching of English.) Students making English their minor may be admitted to such courses as in the judgment of the instructors in charge they are qualified to pursue.

Degree of Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates for the Master of Arts in English are required to choose at least four of their courses from those at the 400 level. They must also give evidence that they have taken the equivalent of at least two years of undergraduate work in French or German (Latin or Greek may be substituted). They may do this by presenting evidence that they have satisfactorily completed two years of undergraduate study in either language, by passing the reading examination of the Graduate College in either language, or by taking and passing with a grade of C either French 400 and 401 or German 400 and 401.

Candidates must also pass a qualifying examination. This is a three-hour written examination devised to test the student's possession of the knowledge of English and American literature which an undergraduate English major may be reasonably expected to have acquired. The examination will be given during the first week of each semester and of the summer session. It must be taken during the student's first term of residence. As a guide to prospective candidates, it is suggested that the following undergraduate courses or their equivalent will best fit the pattern of the examination: a course in a major writer (e.g., Shakespeare, Chaucer, Milton, or Melville), a course in a period of literature (e.g., the Renaissance or the eighteenth century), a course in a literary type (e.g., drama, satire, or novel), and surveys of English and American literature. Preparation for the examination should involve a review of the history of English literature, emphasizing the major works and major authors of various periods.

A master's thesis is not required, although a student may elect to offer one, with the approval of his adviser. The Head of the Department is *ex officio* adviser to all candidates for the degree of Master of Arts in English.

Degree of Master of Arts in the Teaching of English. Candidates for the degree of Master of Arts in the Teaching of English must earn four units in English (at least two of these in courses at the 400 level); and they must pass the same qualifying examination as is required for the degree of Master of Arts in English. They must also give evidence that they have taken the equivalent of at least two years of undergraduate work in French, German, Spanish, Greek, or Latin. They may do this by presenting evidence that they have satisfactorily completed two years of undergraduate study in any of the languages, by passing the reading examination of the Graduate College in French or German, or by taking and passing with a grade of C either French 400 and 401 or German 400 and 401.

Specific requirements are English, four units (students who intend to teach in junior college should take Rhetoric 480); education, two units, including two of the following courses: Education 301, Philosophy of Education; Education 302, History of American Education; Education 303, Comparative Education; Education 304, Social Foundations of Education, one unit; and Education 311, Psychology of Learning for Teachers; and Education 312, Mental Hygiene and the

School, one unit. The courses in English and the electives must be selected with the approval of the Head of the Department. The electives may be in English, in education, or, in exceptional cases, in other subjects. Candidates for this degree should consult Professor J. N. Hook, 121 Lincoln Hall.

Degree of Doctor of Philosophy. Candidates for the degree of Doctor of Philosophy in English may expect to be examined on the entire field of English language and literature. Candidates with literature as a major will take philology as a first minor. They are urged, furthermore, to acquaint themselves as fully as possible with the history and philosophy of the period in which their main interest lies, and with the foreign languages and literature most closely related to English and that period. Further information concerning the requirements for this degree is provided in the departmental pamphlet, which may be obtained at 204a Lincoln Hall.

ASSISTANTSHIPS

Teaching assistantships in English are available to graduate students who wish to combine teaching experience with progress toward advanced degrees. Applicants with the A.M. degree are eligible for full-time assistantships paying $2,700 on a nine-month contract. Students given such appointments ordinarily teach three three-hour classes of Freshman Rhetoric. Those who are working toward the A.M. degree and those who wish to progress more rapidly toward the doctorate may be considered for two-thirds time ($1,800) or one-third time ($900) appointments. All appointments to assistantships are for nine months only but may be renewed annually if teaching services are needed and both teaching and graduate work are satisfactory. Applications should be addressed to Professor Charles W. Roberts, Director of Freshman Rhetoric, 204a Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: G. N. Ray (Head of Department), T. W. Baldwin, J. T. Flanagan, H. F. Fletcher, R. A. Gettmann, M. T. Herrick, J. N. Hook, P. N. Landis, H. Larsen, J. J. Parry, C. W. Roberts, A. W. Secord, R. M. Smith.

Associate Professors: E. H. Davidson, G. B. Evans, M. S. Goldman, A. G. Holaday, B. A. Milligan, R. W. Rogers, C. H. Shattuck.

Assistant Professors: Margaret French, G. P. Haskell, Cornelia P. Kelley, E. G. Mathews, S. Paul, G. B. Stillwell.

English Literature

COURSES FOR GRADUATES

400. **Introduction to Advanced Graduate Study.** A consideration of the methods of literary scholarship, the objectives of literary criticism, and the profession of college English teaching. Required of all candidates for the degree of Doctor of Philosophy in English. I; ½ unit. Prerequisite: A Master of Arts degree or its equivalent. Gettmann, Ray, Rogers.

401. **Old English (Anglo-Saxon).** An introduction to the language before 1000 A.D. I; 1 unit. Smith.

402. **Old English (Beowulf).** II; 1 unit. Prerequisite: English 401. Smith.

403. **History of the English Language.** A study of the development of the language from the earliest stages to the present time. I; 1 unit. Smith.

411. **Chaucer and His Times.** A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. I; 1 unit. Smith.

412. **Chaucer and His Times.** Continuation of English 411. II; 1 unit. SMITH.

415. **Middle English.** Introduction to middle English dialects with special emphasis on the East Midland. I; 1 unit. Offered in 1954-1955 and in alternate years. SMITH.

417. **English Literature from the Norman Conquest to 1400.** Primarily literature written in Latin and French (read in translation). I; 1 unit. PARRY.

418. **English Literature from the Norman Conquest to 1400.** A survey of the literature, in all languages, produced in England during the period. II; 1 unit. PARRY.

420. **Medieval Latin (Anglo-Latin Writers).** Study of the English writers of the Middle Ages who wrote in Latin; reading of selections in the original. II; 1 unit. Prerequisite: A reading knowledge of classical Latin. PARRY.

421. **Literature of the Sixteenth Century.** I; 1 unit. BALDWIN.

422. **Literature of the Sixteenth Century.** Continuation of English 421. II; 1 unit. BALDWIN.

425. **Seminar in Spenser.** A study of special problems relating to the works of Edmund Spenser, his background in England and in Ireland, and the second half of the sixteenth century. I; 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: English 326 or any course in the sixteenth century. SMITH.

427. **Development of Tudor Drama.** I; 1 unit. BALDWIN.

428. **Development of Tudor Drama.** Continuation of English 427. II; 1 unit. BALDWIN.

431. **Shakespeare and Elizabethan Drama.** I; 1 unit. BALDWIN.

432. **Shakespeare and Elizabethan Drama.** Continuation of English 431. II; 1 unit. Prerequisite: English 431. BALDWIN.

433. **Seminar in Elizabethan Drama.** II; 1 unit. BALDWIN.

434. **Seminar in Elizabethan Drama.** The immediate predecessors and early contemporaries of Shakespeare to 1603, exclusive of Shakespeare and Johnson. I; 1 unit. BALDWIN.

435. **Literature of the Seventeenth Century.** I; 1 unit. FLETCHER.

436. **Literature of the Seventeenth Century.** Continuation of English 435. II; 1 unit. FLETCHER.

441. **Seminar in Milton and His Age.** I; 1 unit. Prerequisite: English 435 and 436; second-year graduate standing. FLETCHER.

442. **Seminar in Milton and His Age.** Continuation of English 441. II; 1 unit. Prerequisite: English 435 and 436; second-year graduate standing. FLETCHER.

445. **Literature of the Eighteenth Century.** I; 1 unit. SECORD.

446. **Literature of the Eighteenth Century.** Continuation of English 445. II; 1 unit. SECORD.

451. **Studies in the History of the Eighteenth Century Novel.** I; 1 unit. SECORD.

452. **Studies in the History of the Eighteenth Century Novel.** Continuation of English 451. II; 1 unit. SECORD.

455. **Seminar in the History and Theory of Prose Fiction.** I; 1 unit. Prerequisite: Second-year graduate standing. GETTMANN.

456. **Seminar in the History and Theory of Prose Fiction.** Continuation of English 455. II; 1 unit. Prerequisite: Second-year graduate standing. GETTMANN.

459. **The Romantic Movement.** I; 1 unit. GETTMANN.

460. **The Romantic Movement.** Continuation of English 459. II; 1 unit. GETTMANN.

463. **Victorian Literature.** I; 1 unit. Ray.

464. **Victorian Literature.** II; 1 unit. Prerequisite: English 463. Ray.

475. **Studies in Bibliographical Method.** Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. II; 1 unit. Evans.

480. **Background Materials for High School Teachers of English.** Investigation of the content that is desirable in high school literature and composition. S; 1 unit. Hook.

492. **Research in Special Topics (Thesis).** Guidance in writing theses for advanced degrees. I, II; ¼ to 4 units. Baldwin, Evans, Fletcher, Gettmann, Goldman, Herrick, Holaday, Hook, Landis, Larsen, Mathews, Milligan, Parry, Ray, Roberts, Rogers, Secord, Smith, Stillwell.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

511. **Chaucer.** I; ½ to 1 unit. Stillwell.

513. **Introduction to the Literature of the Middle Ages.** The literature of western Europe from 1000 to 1500. The literary background, and the literature of the castle. I; ½ to 1 unit. Parry.

514. **Introduction to the Literature of the Middle Ages.** The literature of western Europe from 1000 to 1500. Lyric poetry; the literature of the cloister and the tavern. II; ½ to 1 unit. Parry.

525. **English Literature from 1588 to 1660.** A survey of English literature during the Renaissance. Sidney, Marlowe, Donne, Jonson, Herrick, Bacon, Burton, and other writers. II; ½ to 1 unit. Milligan.

526. **Spenser.** II; ½ to 1 unit. Goldman.

536. **English Drama Exclusive of Shakespeare.** From 1600 to 1700. II; ½ to 1 unit. Herrick.

537. **Studies in Shakespeare.** Nine plays. Special attention given to the modern critical approach and to the principal Shakespearean critics. Prerequisite: English 131 or equivalent; consent of instructor. S; ½ to 1 unit. Evans.

538. **Tragedy.** Comparative study of masterpieces in several periods of Western culture. Major emphasis on Ancient Greek and Roman, and English Elizabethan and Stuart drama. I, II; ½ to 1 unit.

542. **The Poetry of Milton.** Origins, forms, artistic and ethical values; Milton's place in English literary history. II; ½ to 1 unit. Fletcher.

545. **The Metaphysical Poets.** Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughan, Crashaw), with special emphasis on the poetry of John Donne. I; ½ to 1 unit. Evans, Milligan.

546. **The Age of Dryden.** A study of Restoration literature, dramatic and nondramatic, centered around Dryden. I; ½ to 1 unit. Evans.

547. **Alexander Pope.** Pope's prose and poetry together with selections from Pope's classical models (in translation). II; ½ to 1 unit. Rogers.

549. **Dr. Johnson and His Circle.** The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan. Lectures will establish the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. I or II; ½ to 1 unit. Rogers.

551. **The Mid-Victorian Novel.** Thackeray, Charlotte Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. II; ½ to 1 unit. Ray.

555. **Survey of English Literature.** From the beginning to 1700. I, II; ½ to 1 unit. French, Holaday, Milligan, Parry, Rogers.

356. **Survey of English Literature.** From 1700 to 1900. I, II; ½ to 1 unit. French, Holaday, Milligan, Parry, Rogers.

363. **Introduction to Comparative Literature.** Same as German 363. A comparative study of great books in Greek, Roman, Italian, and Spanish literature. I; ½ unit. Allen, Landis, Van Horne.

364. **Introduction to Comparative Literature.** Same as German 364. A comparative study of great books in French, German, and English literature. II; ½ unit. Jacob, Landis, Schumann.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as Speech 371. I; ½ to 1 unit. Herrick.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as Speech 372. II; ½ to 1 unit. Herrick.

382. **The Plays of Bernard Shaw.** I; ½ to 1 unit. Prerequisite: English 281. Shattuck.

383. **English Literature in the Twentieth Century.** An introductory survey emphasizing Shaw, the Edwardian novelists, Yeats, Joyce, Lawrence, Eliot, the Bloomsbury group, the satirists of the twenties, and such recent writers as Auden, Orwell, and Graham Greene. I; ½ to 1 unit. Ray.

American Literature

COURSES FOR GRADUATES

439. **Problems in American Literature and Cultural History.** A conference and research course devoted to intensive studies in the relation of selected writers and problems in American literature to critical movements. I; 1 unit. Prerequisite: At least a survey of American literature, or consent of instructor. Flanagan, Paul.

440. **Problems in American Literature and Cultural History.** Continuation of English 439. II; 1 unit. Prerequisite: At least a survey of American literature, or consent of instructor. Davidson, Flanagan.

492. **Research in Special Topics (Thesis).** Guidance in writing theses for advanced degrees. I, II; ¼ to 4 units. Davidson, Flanagan, Haskell, Kelley, Paul.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **The American Drama.** An historical survey of the American drama from the beginning to Clyde Fitch, including the reading of a large number of representative plays. I; 1 unit. Offered in 1954-1955 and in alternate years. Flanagan.

316. **The American Drama.** An historical survey of the American drama from Clyde Fitch to the present, including the reading of a large number of representative plays. II; 1 unit. Offered in 1954-1955 and in alternate years. Flanagan.

318. **The American Novel: Cooper to Norris.** Cooper, Hawthorne, Melville, James, Twain, Howells, Norris, Glasgow. I, II; ½ to 1 unit. Davidson, Haskell.

352. **American Literature: Irving to Whitman.** A study of the major American writers from 1800 to the Civil War with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. II; ½ to 1 unit. Davidson, Paul.

353. **Studies in Middle Western Literature.** A survey of Middle Western literature from about 1825 to Dreiser, with special emphasis on the development of

realism in poetry and fiction. I; 1 unit. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

354. **Studies in Middle Western Literature.** A survey of Middle Western literature from Dreiser to the present, with special emphasis on the development of realism in poetry and fiction. II; 1 unit. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

357. **Folklore in American Literature.** A study of American folklore, including folk tales, themes, and characters, with special references to the appearance of such material in American fiction, poetry, and drama. I; ½ to 1 unit. FLANAGAN.

375. **Henry James and the Technique of Fiction.** A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. I; ½ to 1 unit. KELLEY.

376. **American Criticism and American Culture.** This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. II; ½ to 1 unit. Prerequisite: English 113 and 114 or English 255 and 256. PAUL.

381. **The Twentieth Century American Novel.** Dreiser, Fitzgerald, James, Hemingway, Lewis, Anderson, Dos Passos, Wolfe, Faulkner, and Steinbeck. I; ½ to 1 unit. SCOUFFAS.

Rhetoric and Composition

COURSES FOR GRADUATES

480. **The Theory and Practice of English Composition.** An examination of modern prose style and a consideration of problems confronting writers and teachers of writing at the college level. I, II; 1 unit. Prerequisite: Consent of instructor. ROBERTS.

ENTOMOLOGY

The Department of Entomology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. A prerequisite for graduate work in entomology is a grade-point average of at least 3.5 during the last two years of undergraduate training, exclusive of required military training and physical education. Students are not admitted on limited status. In addition, two years of undergraduate work in biology including zoology and entomology are required. A candidate who chooses entomology as a major for an advanced degree must have had at least six hours of undergraduate credit in entomology. A reading knowledge of either French or German is required by the beginning of the second year of graduate study.

There are four chief fields of specialization in the department: general entomology (including morphology and taxonomy), insect bionomics, economic entomology (including medical entomology, insect control, and toxicology of insecticides), and insect physiology.

If a sole minor is elected it must involve four units outside the department in one of the following areas: agronomy, bacteriology, botany, including plant pathology, chemistry, horticulture, physiology, and zoology. A first minor (two units) may be taken in a field of specialization in entomology other than the

major, and the second minor (two units) must be in a related subject outside the department.

The department is well equipped to offer work in these areas and the facilities of the State Natural History Survey are also available for advanced study. Outstanding entomological library facilities are located on the campus.

Candidates for the master's degree must write a thesis and pass an oral examination covering the general field of entomology. At the option of the faculty, a written examination may also be required.

Candidates for the degree of Doctor of Philosophy in Entomology must pass examinations in two foreign languages and the usual oral preliminary examination before entering the last year of residence. At the preliminary examination a candidate must exhibit a broad background in the whole field of entomology and a knowledge of general biological principles. Candidates should pursue a course of independent private study to include such fields as the history of biology, zoology, and entomology; the philosophy of science; biological literature and biological statistics.

Theses required for the master's and doctor's degrees are due in the office of the Department of Entomology ten days before they are due in the office of the Graduate College. During this ten-day period theses are available for reading and correcting by faculty members in order that suggested changes may be made in them before they are delivered to the Dean of the Graduate College.

FELLOWSHIPS AND ASSISTANTSHIPS

A number of University fellowships are available in the Graduate College. For a description of application procedures, stipends, and requirements, refer to the beginning section of this catalog.

Three half-time teaching assistantships are available in the department.

Several half-time research assistantships are available through research grants of the United States Public Health Service, the Army Quartermaster Corps, United States Navy, the Surgeon General's office, and the Rockefeller Foundation. These require service of twenty hours a week, and the remaining time is spent in graduate study. These provide varying stipends for nine months or twelve months service and exemption from fees. These assistantships are for work in the fields of insect physiology, medical entomology, and insecticides.

In the Division of Economic Entomology of the Illinois State Natural History Survey, three half-time assistantships are available for control studies of economic insects. These carry various stipends and fee exemption.

For information concerning assistantships in the Illinois State Natural History Survey, write Professor George C. Decker, 123 Natural Resources Building, Urbana, Illinois. For application blanks and information concerning assistantships, write the Head of the Department of Entomology. Fellowship application blanks are available from the Dean of the Graduate College.

GRADUATE TEACHING FACULTY

Professors: W. P. Hayes (Head of Department), W. V. Balduf, G. C. Decker, G. S. Fraenkel, C. W. Kearns, V. G. Milum, H. H. Ross.

Associate Professor: W. R. Horsfall.

COURSES FOR GRADUATES

407. **External Insect Anatomy.** A comparative study of the external anatomy of various orders of insects. I; 1 unit. Hayes.

408. **Internal Insect Anatomy.** A comparative study of the internal anatomy of various orders of insects. II; 1 unit. Prerequisite: Entomology 407. Hayes.

25. **Seminar in Entomology.** I; ¼ unit.

26. **Seminar in Entomology.** II; ¼ unit.

93. **Research.** Work may be taken in the following subjects; morphology and embryology of insects, economic entomology, systematic entomology, biology and ecology of insects, insect physiology. I; ½ to 4 units. Balduf, Decker, Fraenkel, Hayes, Horsfall, Kearns, Milum, Ross.

94. **Research.** Work may be taken in the following subjects: morphology and embryology of insects, economic entomology, systematic entomology, biology and ecology of insects, insect physiology. II; ½ to 4 units. Balduf, Decker, Fraenkel, Hayes, Horsfall, Kearns, Milum, Ross.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

06. **Special Problems.** For students ready to take up some special investigation which may be completed as an undergraduate study or the beginning of a thesis problem for an advanced degree. It may also be used to prepare a thesis for scholastic honors. I, II; ¼ to 1 unit. Prerequisite: Any of the following: Entomology 131, 308, 309, 310, 313, 317, 318, 319, 320, 322, 323, 324, or Zoology 101 or 321. Balduf, Decker, Fraenkel, Hayes, Horsfall, Kearns, Milum, Ross.

08. **Insect Pests of Field Crops.** II; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Entomology 101. Hayes.

09. **Morphology and Taxonomy of Immature Insects.** A study of the structures of nymphs, larvae, and pupae. This course is devoted to morphological studies which are followed by taxonomic studies in Entomology 310. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Consent of instructor. Hayes.

0. **Morphology and Taxonomy of Immature Insects.** A study of the taxonomy of nymphs, larvae, and pupae. A sequence to Entomology 309. II; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Entomology 309. Hayes.

1. **Insect Taxonomy.** A one-semester course in the classification of insects designed for biology teachers, and students in agriculture, game management, conservation, zoology, and those in entomology who can not register for both Entomology 317 and 318. Some of the laboratory time is spent studying and collecting insects in the field. An insect collection is made and identified. S; 1 unit. Prerequisite: Entomology 101 or 103, or a course in biology. Balduf, Hayes, Horsfall, Kearns.

2. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelations with the other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent. Balduf.

3. **Medical and Veterinary Entomology.** Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of diseases among men and domestic animals. I; ½ or 1 unit. Prerequisite: Entomology 101 or 103, or Zoology 320. Horsfall.

6. **Advanced Economic Entomology.** A consideration of the principles underlying ways and means of preventing injury to crops and various products. II; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Entomology 101 or 103. Horsfall.

317. **Classification of Insects.** Orders with gradual metamorphosis, and principles of systematic entomology. The distinctive structural features of the orders comprising the Ametabola and Heterometabola; comparison of various systems of classification of the orders; how to recognize the more common families; practice in keying to species. The principles embrace sources of material, segregation, preparation of keys, descriptions, bibliographies, and outlines for revisional papers. I; 1 unit. Prerequisite: Entomology 101 or 103, or equivalent. BALDUF.

318. **Classification of Insects.** Orders with complete metamorphosis and principles of systematic entomology. Distinctive structural features of the orders comprising the subclass Holometabola; comparison of the various systems of classification of the orders; how to recognize the more common families; practice in keying to species; literature; biographies. II; 1 unit. Prerequisite: Entomology 101 or 103, or equivalent. BALDUF.

319. **Chemical Control of Insects.** Discussion and actual practice in the most effective control measures for insect pests; training for professional or commercial work as an entomologist, pest control supervisor, or agricultural agent. II; 1 unit. Prerequisite: Entomology 101 or 103, or a course in economic entomology. KEARNS.

320. **Chemistry and Toxicology of Insecticides.** Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. I; ½ unit. Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. KEARNS.

322. **Insect Bionomics.** This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. II; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Entomology 101 or 103, or Zoology 320. HORSFALL.

323. **Insect Physiology.** I; 1 unit. Prerequisite: A course in organic chemistry; consent of instructor. FRAENKEL.

324. **Insect Physiology.** II; 1 unit. Prerequisite: A course in organic chemistry; consent of instructor. FRAENKEL.

FOOD TECHNOLOGY

(Including Dairy Technology)

The Department of Food Technology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in both Food Technology and Dairy Technology.

Students undertaking graduate work in either dairy or food technology must have a grade-point average of at least 3.5 in the final two years of undergraduate work, exclusive of required physical education and military training. Students admitted on a grade-point average below 3.75 will be accepted only under the condition that their records will be subject to departmental review after they have completed four units of work and that determination of their acceptability to continue on an advanced degree program will be made at that time.

A student planning to take a major or minor in dairy technology should have had previous training as an undergraduate in this field. It is also desirable for the student to have had a course in statistics, advanced undergraduate training in mathematics and chemistry, and at least a year of French or German.

Minors may be selected from the following fields of study: economics, agricultural economics, business organization and operation, chemistry, bacteriology, physics, nutrition, veterinary medicine, and dairy production. Requirements for the minors will be established by the respective departments concerned.

To obtain a master's degree in dairy technology, a student must have credit n Chemistry 350, Dairy Technology 401 (one unit), 404 (one unit), and 493 (two units). A course in statistics is also necessary unless such a course was taken by the student when an undergraduate. The remainder of the eight units required or the Master of Science degree can be taken in the major and minor fields.

Candidates for the degree of Doctor of Philosophy in Dairy Technology hould complete the requirements for their minors by the end of the second year of residence so that the last year can be spent in research on their thesis problems Dairy Technology 493). Each candidate will be required to pass a written examination at the end of the second year of residence but before the oral preliminary examination for the doctorate.

Second-year and third-year graduate students are expected to attend all seminars (Dairy Technology 404) in dairy technology, but they can register for a naximum of only one unit of credit.

A student planning to take a major or minor in food technology should have a Bachelor of Science degree in food technology or in a major field of chemistry, bacteriology, chemical engineering, horticulture, or other recognized field of biological, physical, agricultural, or engineering science in which a minimum of the undergraduate credits are as follows: college biology, six hours; college physics, ight hours; calculus, six hours; bacteriology, five hours; analytical chemistry, five hours; organic chemistry, five hours; physical chemistry, four hours; and food echnology or equivalent, twenty hours. Deficiencies in any of these requirements nay be made up during the first year of graduate study, but no graduate credit vill be given.

To obtain a graduate degree in food technology, a student must have credit graduate or undergraduate) in Bacteriology 308, Chemistry 329 and 350, and Food Technology 301, 302, 332, 421 (M.S., one-half unit; Ph.D., one unit), nd 493 (M.S., two units; Ph.D., eight units). Minors may be selected from he fields of physical, biological, agricultural, or engineering science, and must be approved by the department.

Research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing.

Candidates for the master's degree must complete one language requirement German, French, or Spanish) and one minor (minimum one unit) and will be equired to take an examination covering the field of general food technology nd of their specialization. This will be primarily an oral examination although, t the option of the faculty, it may include a written section. A thesis is required nd must be in the office of the Department of Food Technology ten days before it s due in the Graduate College office.

Candidates for the degree of Doctor of Philosophy in Food Technology must omplete two language requirements (German and French or Spanish) and must ave at least one minor subject. If a sole minor, a minimum of four units must be arned or, if accompanied by a second minor, a minimum of two units in each ninor. The formal course work should be completed by the end of the second ear in residence so that the last year can be spent in research on the thesis problem. A comprehensive written qualifying examination covering the general field f food technology and the minor fields of study will be given after the student has ompleted sixteen units of graduate work and has satisfied the two language requirements. The results of this examination will serve the adviser as a guide in etermining the student's readiness to appear for the preliminary oral examination. The thesis must be in the office of the Department of Food Technology ten days efore it is due in the Graduate College office.

Graduate credit courses offered outside the Department of Food Technology nay be applied in partial satisfaction of the major unit requirements. These may e selected from closely related fields of study, such as bacteriology, chemistry,

physics, engineering, and applied biological sciences, and are subject to the approval of the major department.

FELLOWSHIPS AND ASSISTANTSHIPS

The Department of Food Technology has industrial or institutional fellowships and research and teaching assistantships, varying in number from year to year. These are open to all students entering graduate study. Applications for fellowships or assistantships should be made directly to the Food Technology Department.

GRADUATE TEACHING FACULTY

Professors: R. T. Milner (Head of Department), E. O. Herreid, L. B. Howard, P. H. Tracy.
Associate Professors: F. A. Kummerow, A. I. Nelson, Z. J. Ordal, S. L. Tuckey, R. M. Whitney.
Assistant Professors: O. W. Kaufmann, J. Tobias.

Food Technology

COURSES FOR GRADUATES

404. **The Technology of Fats and Oils.** Lectures, reference readings, and demonstrations on the factors involving the technology of fats and oils. II; ½ unit. Prerequisite: Food Technology 393. Kummerow.

406. **The Technology of Fats and Oils.** Laboratory, reference readings, and demonstrations on the factors involving the technology of fats and oils. II; ½ unit. Prerequisite: Credit or registration in Food Technology 404. Kummerow.

421. **Seminar.** Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food technology. I, II; ½ unit. Kaufmann, Kummerow, Milner, Nelson, Ordal.

481. **Advanced Studies in Food Technology.** Library or laboratory assignments on specific problems of limited scope involving individual commodities or processes. I, II; ½ to 2 units. Kummerow, Milner, Nelson, Ordal.

493. **Research.** I, II; ½ to 4 units. Kummerow, Milner, Nelson, Ordal.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, dehydrating, and fermenting methods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. I; 1 unit. Prerequisite: Food Technology 201 or equivalent. Nelson.

302. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats, fish, and poultry products; and extraction and refining of vegetable oils. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. II; 1 unit. Prerequisite: Food Technology 202 and 301, or equivalent. Nelson.

332. **Principles of Sanitation in the Processing and Handling of Foods.** Same as Veterinary Pathology and Hygiene 332. A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to

various food processing industries. Control of insects, rodents, and microorganisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods. Government and public health regulations. Local field trips to food processing plants. II; ½ unit. Prerequisite: Bacteriology 104 and 105, Chemistry 132, or equivalents. ORDAL.

363. **Introduction to Process Engineering.** Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food technology; not open to majors in chemical engineering. I; ¾ unit. Prerequisite: Chemistry 240 or 247 and one year of calculus. FINN.

373. **Advanced Food Microbiology.** A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. I; 1¼ units. Prerequisite: Bacteriology 308 and Chemistry 133, or equivalent. ORDAL.

391. **The Technology of Fats and Oils.** Lectures, reference readings, and demonstrations on the factors involving the technology of fats and oils. I; ½ unit. Prerequisite: Credit or registration in Chemistry 350 or consent of instructor. KUMMEROW.

393. **The Technology of Fats and Oils.** Laboratory, reference readings, and demonstrations of the factors involving the technology of fats and oils. I; ½ unit. Prerequisite: Credit or registration in Food Technology 391. KUMMEROW.

Dairy Technology

COURSES FOR GRADUATES

401. **Advanced Principles of Dairy and Food Technology.** Study of fundamental physico-chemical problems involved in the processing of milk and milk products. II; 1 unit. Prerequisite: Chemistry 350. HERREID.

403. **Colloid Phenomena of Dairy and Other Food Products.** A study of the colloidal phenomena involved in the processing of dairy and other food products. I; 1 unit. Prerequisite: Chemistry 249. WHITNEY.

404. **Seminar.** Review of current literature in dairy technology. Students may register for credit only twice for a maximum of one unit. I, II; 0 to ½ unit. TRACY.

491. **Assigned Problems in Dairy Technology.** Research on special problems for graduate students with a major interest in dairy technology. I, II; 1½ to 2 units. HERREID, TRACY, TUCKEY, WHITNEY.

493. **Thesis.** I, II; ½ to 4 units. HERREID, ORDAL, TRACY, TUCKEY, WHITNEY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

401. **Ice Cream Manufacture.** Technical problems and methods involved in the manufacture of commercial ice cream, sherbets, and ices. I; ½ unit. Prerequisite: Dairy Science 150 and 151, Dairy Technology 101, or consent of instructor. TOBIAS, TRACY.

402. **Creamery Butter Manufacture.** Preparation of cream, churning, and packaging of butter. II; ½ unit. Prerequisite: Dairy Science 150 and 151, Dairy Technology 101, or consent of instructor. TUCKEY.

403. **Cheese Manufacture.** Manufacture and ripening procedures for domestic and foreign types of cheese. I; ½ unit. Prerequisite: Dairy Science 150 and 151, Dairy Technology 101, or consent of instructor. TUCKEY.

304. **Market Milk.** Production, quality control, assembling, and processing of fluid milk and related products. I; ½ unit. Prerequisite: Dairy Science 150 and 151, Dairy Technology 101, or consent of instructor. HERREID.

306. **Condensed Milk and Milk Powder Manufacture.** Methods of manufacturing different types of condensed and dried milks. II; ½ unit. Prerequisite: Dairy Science 150 and 151, Dairy Technology 101, or consent of instructor. TOBIAS, TRACY.

308. **Plant Management.** Problems in the organization, financing, labor management, and operation of dairy plants. II; ½ unit. TRACY.

FRENCH

(Including Russian)

The Department of French offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Students with a minimum grade-point average of 3.5 or above in the last two years of undergraduate work, exclusive of required courses in physical education and military training, are regularly admitted to graduate courses in French, subject to fulfillment of other prerequisites. Students on limited status may be accepted according to the individual case.

Students electing French as a major subject should have had the equivalent of at least four years of French in college, including practical work in the use of the language and an advanced course in literature. Some knowledge of other Romance languages and literatures is desirable. A basic knowledge of Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject will be admitted to courses for which they are adequately prepared.

Degree of Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates for the degree of Master of Arts in French must pass an examination based on a general reading list. Candidates preparing to teach French will take French 409 and 410, unless they can demonstrate proficiency.

Degree of Doctor of Philosophy in French. Candidates for this degree are required to include French 475 and 476, for which some knowledge of Latin is essential. These courses may be counted as the field of a first minor subject.

Degree of Master of Arts in the Teaching of French. Candidates for the degree of Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 409 and 410, two units; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields. The grade-point average is the same as that required by the department for admission. Students on limited status will not be admitted. The adviser for candidates for this degree is Professor J. F. Jackson, 226 Lincoln Hall.

ASSISTANTSHIPS

A limited number of teaching assistantships are generally available. These are ordinarily on a part-time basis, providing a distribution of work between teaching and study. Applications for assistantships should be addressed to the Head of the Department.

GRADUATE TEACHING FACULTY

Professors: C. A. KNUDSON (Head of Department), J. F. JACKSON, J. R. SMILEY, P. A. WADSWORTH.

Associate Professors: C. C. Gullette, P. E. Jacob, P. Kolb, C. P. Viens.
Assistant Professors: R. E. Hallowell, Frances F. Sobotka.

OURSES FOR GRADUATES

0. **Beginning French for Graduate Students.** Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. degree. I, II; no graduate credit.

1. **Reading French for Graduate Students.** Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. degree. I, II; no graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

9. **The Phonetics of French.** A descriptive study of the sounds of French, with exercises for the improvement of pronunciation and diction. Conducted in French. I; 1 unit. Knudson.

0. **Advanced Syntax.** An advanced theoretical and practical study of present-day French, with some consideration of stylistics. Conducted in French. II; 1 unit. Knudson.

1. **History of Old French Literature, I.** Lectures on the history of French literature from the eleventh through the thirteenth century, with particular attention to epic and romance. Illustrative reading in translation. I; ½ unit. Offered in 1955-1956 and in alternate years. Knudson.

2. **History of Old French Literature, II.** II; ½ unit. Knudson.

3. **Villon, Rabelais.** I; 1 unit.

4. **Montaigne, La Pléiade.** II; 1 unit.

5. **Seventeenth Century Literature, I.** I; 1 unit. Offered in 1955-1956 and in alternate years. Wadsworth.

6. **Seventeenth Century Literature, II.** II; 1 unit. Offered in 1955-1956 and in alternate years. Wadsworth.

7. **Eighteenth Century Literature, I.** I; 1 unit. Offered in 1954-1955 and in alternate years. Wadsworth.

8. **Eighteenth Century Literature, II.** II; 1 unit. Offered in 1954-1955 and in alternate years. Wadsworth.

7. **Nineteenth Century Literature to 1850, I.** I; 1 unit. Offered in 1954-1955 and in alternate years. Jackson.

8. **Nineteenth Century Literature to 1850, II.** II; 1 unit. Offered in 1954-1955 and in alternate years. Jackson.

3. **French Realism and Naturalism, I.** I; 1 unit. Offered in 1955-1956 and in alternate years. Jackson.

4. **French Realism and Naturalism, II.** II; 1 unit. Offered in 1955-1956 and in alternate years. Jackson.

7. **Seminar in Proust, I.** I; ½ unit. Kolb.

8. **Seminar in Proust, II.** II; ½ unit. Kolb.

5. **La Littérature Contemporaine, I.** In French. Poetry: Baudelaire. Symbolism up to Valéry. Prose writers from 1900 to 1940. I; 1 unit. Offered in 1954-1955 and in alternate years. Jacob.

6. **La Littérature Contemporaine, II.** II; 1 unit. Offered in 1954-1955 and in alternate years. Jacob.

5. **Old French Philology, I.** Reading of characteristic masterpieces of medieval French literature, and study of the development of the Old French language

from Latin. I; 1 to 1¼ units. Prerequisite: Consent of instructor; elementary knowledge of Latin; reading knowledge of German. KNUDSON.

476. **Old French Philology, II.** II; 1 to 1¼ units. Prerequisite: French 475. KNUDSON.

491. **Research and Thesis.** I; 1 to 4 units. JACKSON, JACOB, KNUDSON, KOLB, SMILEY, WADSWORTH.

492. **Research and Thesis.** II; 1 to 4 units. JACKSON, JACOB, KNUDSON, SMILEY, WADSWORTH.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. **Survey of French Literature, I.** I; ¾ unit. Prerequisite: French 202 or equivalent; consent of instructor. JACKSON.

310. **Survey of French Literature, II.** II; ¾ unit. Prerequisite: French 202 or equivalent; consent of instructor. JACKSON.

317. **Modern French Drama, I.** I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: French 202 or equivalent; consent of instructor. VIENS.

318. **Modern French Drama, II.** II; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: French 202 or equivalent; consent of instructor. VIENS.

323. **French Drama of the Seventeenth and Eighteenth Centuries.** I; ¾ unit. Prerequisite: French 201 and 202, or equivalent; consent of instructor. KOLB.

324. **French Comedy of the Seventeenth and Eighteenth Centuries.** II; ¾ unit. Prerequisite: French 201 and 202, or equivalent. KOLB.

331. **French Novel of the Nineteenth Century, I.** From Balzac to Proust. I; ¾ unit. Prerequisite: French 201 and 202. JACOB.

332. **French Novel of the Nineteenth Century, II.** From Balzac to Proust. II; ¾ unit. Prerequisite: French 201 and 202. JACOB.

333. **La Littérature Contemporaine, I.** In French. Modern poetry from Baudelaire to Valéry. Prose writers from 1900 to 1940. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: French 201 and 202. JACOB.

334. **La Littérature Contemporaine, II.** II; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: French 201 and 202. JACOB.

335. **French Civilization, I.** I; ½ unit. Prerequisite: French 202 or equivalent; consent of instructor. JACKSON.

336. **French Civilization, II.** II; ½ unit. Prerequisite: French 202 or equivalent; consent of instructor. JACKSON.

Russian

Courses in the Russian language are under the administration of the Department of French. Inquiries concerning courses in Russian should be directed to the Head of the Department of French.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. **The Russian Novel of the Nineteenth Century.** Readings in Turgenev and Tolstoi. Historical and literary background of the period. I; ½ unit. Prerequisite: Russian 204 or consent of instructor. SOBOTKA.

322. **The Russian Novel of the Nineteenth Century.** Readings in Tolstoi and Dostoevski. Historical and literary background of the period. II; ½ unit. Prerequisite: Russian 321 or consent of instructor. SOBOTKA.

GENETICS

Those desiring a general training in genetics may take a major or minor in botany or zoology. Those desiring to approach agricultural problems through genetics may take a major or minor in agronomy, horticulture, animal science, or dairy science. For courses in the subject see departments of Agronomy, Animal Science, Botany, Dairy Science, Horticulture, and Zoology. An interdepartmental genetics seminar is held at 4 p.m. on the second, third, and fourth Mondays, in 104 Animal Genetics Building.

GEOGRAPHY

The Department of Geography offers graduate work leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy. The following fields of geography are available for specialization in graduate study: climatology, economic geography, cartography, land utilization, conservation of resources, regional geography, political geography, historical geography, and educational geography.

Students applying for admission must have a 3.5 grade-point average for that portion of the work which represents the last fifty per cent of the hours earned toward the bachelor's degree, exclusive of required courses in physical education and military training. Students on limited status will not be admitted. All candidates for advanced degrees in geography must have an average of at least 4.0 in previous work in geography. Candidates for the Ph.D. have full departmental status if they have completed work essentially equivalent to that required for the master's degree by the Department, if their previous graduate record is well above 4.0 and if their qualifications promise superior ability. All others will be placed in provisional departmental status and must demonstrate their ability to carry graduate study during their first semester in residence.

Degree of Master of Arts or Master of Science. Successful candidates for the master's degree whose background is largely in physical geography will be recommended for the degree of Master of Science; others will receive the degree of Master of Arts. The program leading to the master's degree in geography is to add breadth to the student's geographic knowledge and to introduce the student to semi-independent accumulation and use of the geographic materials in seminars, and to independent research and advanced study. Adequate latitude in course requirements is provided to allow the candidate to complete his understanding of the broad aspects of geography (depending on his undergraduate concentration) and to begin to penetrate more deeply into specific phases of geographic content. In this way the master's degree can be either a terminal degree, or it can lead directly into the more intensive study toward the doctorate.

Entering master's candidates are expected to offer at least eighteen hours of undergraduate work in geography in addition to a beginning course; those offering less than this amount must correct this deficiency without graduate credit. At least four of the minimum of eight units of graduate credit required for the master's degree will be in geography, and all eight may be in geography. In individual cases, additional units of work may be required by the Departmental Graduate Committee. Students must have had, either as an undergraduate or as a graduate, training in climatology, map construction and map reading and interpretation, introductory field work, cultural geography, and regional geography. They must also have proficiency equivalent to that expected of an Illinois undergraduate major in a physical or biological science, in a social science, in statistical method, and in oral and written expression. Geology, botany, soils, or zoology are recommended as physical or biological sciences; economics, history, political

Students consulting maps from the collection of 170,000 in the Uni
Library.

science, sociology, or anthropology are recommended in the social sciences. Candidates for the master's degree may use one and one-half units of graduate credit to correct content deficiencies in these divisions of geography and cognate fields.

All candidates for the degree of Master of Science or Master of Arts in Geography must take Geography 477; two of the following graduate seminars: Geography 412, 421, and 497; and at least one-half unit of independent advanced study (Geography 495). Students are advised to enroll in Geography 478 during their master's program, although this course is not a degree requirement.

Degree of Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are electives, two units in education, and two units in electives. Requirements are Geography 493, one unit; Geography 495, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in geography and the other electives must be selected with the approval of the adviser. Two electives must be in geography, and the other two in geography, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as required by the Department. No limited status students will be admitted to this program. The adviser for candidates for this degree is Professor J. H. Garland, 248 Natural History Building.

Degree of Doctor of Philosophy. The doctoral program presupposes an understanding of geographic patterns. This program is, therefore, intended to increase the student's ability to use his knowledge of geography and its allied fields, and to provide maximum opportunity for the exercise of independent ability. The doctoral student will be encouraged to penetrate deeply into the content, techniques, implications, and significance of specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world.

Candidates for the degree of Doctor of Philosophy in Geography must have taken, either as an undergraduate or as a graduate, all work or the equivalent, which is required in the undergraduate major, master's and doctor's program of the Department. Not more than one and one-half units of credit beyond the eight units required for the Illinois master's degree may be in areas specifically required in the undergraduate major or master's curriculum. Eight of the minimum twenty-four units of graduate credit required for the Ph.D. will be in Geography 493 and will be devoted to the completion of an original and independent doctoral thesis. Geography 493 will be carried subsequent to the admission of the student to candidacy for the degree.

The work required for a Ph.D. in geography is divided into two phases, first, that of preparing a student for formal admission to candidacy for the degree, and second, the satisfactory completion of the doctor's thesis and the support of the thesis in an examination.

Admission to candidacy for the Ph.D. in geography will be recommended after the successful completion of the following requirements:

(1) At least sixteen units of graduate credit, or their equivalent, including four units in official minor fields. At least nine of these sixteen units must be in geography, including Geography 477, 421, 497, 478, and 495. Students concentrating in the physical aspects of geography will enroll in Geography 412; those concentrating in cultural geography, in Geography 463. Equivalent work taken elsewhere will be accepted subject to examination. The Department recommends a split minor, consisting of at least two units in each field. One of the minors should be in geology, botany, soils, or zoology, the other in economics, history, political science, or sociology and anthropology. Other minor fields may be accepted upon recommendation of the major adviser.

(2) The required examinations in foreign languages.

(3) A preliminary examination, which will be administered by a committee

appointed by the Dean of the Graduate College. The examination will cover selected divisions of physical, cultural, and regional geography, the techniques and theory of the discipline, and the student's minor fields.

After being admitted to candidacy for the Ph.D., the student must complete a research thesis which demonstrates his capacity to complete and to support independent and original work in geography. The doctoral thesis will normally require field investigation.

Additional information concerning the requirements of the Department may be obtained from the Head of the Department.

ASSISTANTSHIPS

Teaching assistantships are available in geography. Only students who present records above the minimum requirements for full departmental admission will be considered for assistantships. Application for assistantships should be made to J. A. Russell, Department of Geography, 249 Natural History Building.

GRADUATE TEACHING FACULTY

Professors: J. A. Russell (Head of Department), A. W. Booth, F. W. Foster, J. H. Garland, J. L. Page.
Associate Professor: R. L. Carmin.
Assistant Professor: J. D. Fellmann.
Instructor: H. G. Roepke.

COURSES FOR GRADUATES

412. **Analytical Climatology.** A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. II; 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Page.

421. **Regional Concepts in Geography.** Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. II; ½ unit. Prerequisite: Nine hours of regional geography. Garland.

441. **Bioclimatology.** Same as Physiology 441. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes of mammals, and the application of meteorological, climatological, and geographical techniques in physiological studies. I or II; ½ unit. Prerequisite: Consent of instructor. Page, Sargent.

463. **Historical Geography.** Objectives and methods of historical geography. Prerequisite: Graduate standing in a social science. II; 1 unit. Fellmann.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. II; 1 unit. Prerequisite: Geography 373 or consent of instructor. Foster.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. I; 1 unit. Foster.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. Staff.

493. **Research.** I, II; ½ to 4 units. Staff.

95. **Advanced Studies in Geography.** I, II; ½ to 2 units. Work may be taken in the following fields:

Anglo-America. Garland.

Latin America. Carmin.

Europe. Foster, Roepke.

Asia. Booth, Russell.

U.S.S.R. Fellmann.

Australia and Oceania. Russell.

Economic Geography. Roepke, Russell.

Political Geography. Garland.

Urban Geography. Carmin, Fellmann.

Physical Geography. Booth.

Mathematical Geography. Booth.

Land Utilization and Conservation. Booth, Foster, Roepke, Russell.

Transportation Geography. Booth, Fellmann, Foster.

Problems of Geographic Study. Staff.

97. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. I; ½ unit. Fellmann.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

13. **Climates of the Continents.** A regional treatment of the climates of the world by continents. I; ½ unit. Prerequisite: Geography 101 and 111. Page.

32. **Geography of South America.** A regional geography of South America with emphasis on the southern hemisphere of that continent. II; ½ unit. Prerequisite: Eight hours of geography or enrollment in Latin-American studies program. Carmin.

42. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. I; ½ unit. Prerequisite: Eight hours of geography. Foster.

50. **Geography of World Islands Including Australia.** Physical and cultural landscapes of Australia and the major island groups as habitats for man. II; ½ unit. Prerequisite: Eight hours of geography or consent of instructor.

51. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. I; ½ unit. Prerequisite: Eight hours of geography. Booth.

53. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and transportation. II; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. Fellmann.

61. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is placed on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. Prerequisite: One course in geography or enrollment in the College of Agriculture. I; ½ unit. Roepke.

62. **Manufacturing Regions of the World.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufac-

turing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. Prerequisite: One course in geography, enrollment in the College of Commerce and Business Administration, or enrollment in the College of Engineering. I; ½ unit. ROEPKE.

363. **Production of Great World Minerals.** Geographic aspects of the mineral industries. II; ½ unit. Prerequisite: Eight hours of geography. ROEPKE.

365. **Geographic Aspects of Transportation.** Geographic factors influencing transportation by land, sea, and air. II; ½ unit. Prerequisite: Eight hours of geography. BOOTH.

366. **Problems of Industrial Location.** The relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process. Case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites. II; ½ unit. Prerequisite: Eight hours of geography. Three hours of economic geography for students in the College of Commerce and Business Administration. Engineering and architecture students may register with consent of instructor. RUSSELL.

371. **Introduction to Research.** Limited to seniors and graduates whose major is in geography, and to seniors whose major is in other departments who have twelve hours credit in geography, including three hours in a regional course. Only those students who have four hours credit in Geography 372 and 371 and write a thesis are recommended for graduation with honors. I; ½ unit. FELLMANN, and others.

372. **Introduction to Research.** Limited to seniors and graduates whose major is in geography, and to seniors whose major is in other departments who have twelve hours credit in geography, including three hours in a regional course. Only those students who have four hours credit in Geography 372 and 371 and write a thesis are recommended for graduation with honors. II; ½ unit. STAFF.

373. **Map Compilation and Construction.** Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. I; 1 unit. Prerequisite: Consent of instructor. FOSTER.

375. **Map Reading and Interpretation.** Evaluation of map components, map reading, map interpretation, map history, and survey of world maps and mapping. I; ½ unit. Prerequisite: Consent of instructor. CARMIN.

376. **Field Geography.** Techniques and methods of field investigation; reconnaissance and unit area mapping; collection and use of field data; organization and presentation of materials. Prerequisite: A declared major in geography. II; ½ unit. FOSTER.

378. **Descriptive Interpretation of Aerial Photographs.** Reading and interpreting of aerial photographs; their potentialities and limitations as a research tool of geography. II; ½ unit. Prerequisite: Consent of instructor. FOSTER.

383. **Urban Geography.** The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. I; 1 unit. Prerequisite: Eight hours of geography or consent of instructor. FELLMANN.

386. **Political Geography.** World patterns of nations in relation to their natural environmental backgrounds. European nations; Africa, the exploited conti-

nent; national structures in Asia; western hemisphere nations. I; ½ unit. Prerequisite: Eight hours of geography. Major or graduate students in political science or history may enroll with consent of instructor. GARLAND.

GEOLOGY

Graduate students may take work in geology leading to the degrees of Master f Science and Doctor of Philosophy. Candidates for the master's degree are dvised to plan their work to secure a firm foundation in geology, rather than to pecialize too narrowly. Candidates for the doctor's degree may work in the pecial fields of clay mineralogy, economic geology, geomorphology and glacial eology, mineralogy and petrography, paleontology and stratigraphy, ground-water eology, and sedimentation.

Beginning graduate students admitted to full status in geology must have a rade-point average no lower than 3.75 for that portion of undergraduate work epresenting the last fifty per cent of the hours completed for the bachelor's egree, exclusive of required physical education and military training. Students n limited status will not be admitted to graduate study in geology.

For graduate work in geology a student must usually have had an underraduate major in geology, including field training, and the required courses in hemistry, mathematics, and physics. A reading knowledge of French or German ; desirable for the beginning graduate student and required for the advanced raduate student. An undergraduate major consists of the following courses (or heir equivalent): Geology 102, Historical Geology; 131 and 132, Mineralogy; 01, Geomorphology; 311, Structural Geology; 317, Geology of the San Juan Region, Colorado (or other acceptable summer field experience); 320, Inverterate Paleontology; and 321, Stratigraphy. Graduate students in other departients may be admitted to graduate courses in geology if they have had the rerequisites for the course desired, or by special permission.

A candidate for the master's degree in geology must pass a general examinaion toward the close of the second semester of residence, covering the fields of eology listed in the courses named above and the graduate courses taken.

Graduate students whose undergraduate training has not included all of the major" courses listed may take these courses, if listed as "Courses for Graduates nd Advanced Graduates." More than the minimum of eight units for a master's egree will be required if it is necessary to include an undue number of such 300 ourses.

A reasonable choice of minor may be made by students working for the octor's degree. Ordinarily the minor will be chemistry for those specializing in ineralogy and petrography; chemistry, physics, or mining engineering for ecoomic geology; zoology or botany for paleontology; and agronomy (soils) or eography for geomorphology. Other minors may be chosen with departmental pproval.

ELLOWSHIPS AND ASSISTANTSHIPS

The Illinois Clay Products Company has established two fellowships for raduate study in the field of clay mineralogy. The stipend is $1,500 each for a ear's study plus $500 to cover material and equipment and other expenses reated to the research project.

A fellowship for graduate study in clay mineralogy has been established by he Baroid Sales Division of the National Lead Company. The stipend is $1,500 or a year's study plus $900 for research expenses.

A fellowship established by the Shell Fellowship Committee encourages gradate studies in the field of geology leading to a doctor's degree. The stipend is

$1,500 for a year's study plus $400 to cover material and equipment and othe expenses related to the research project.

The California Company has established a fellowship for graduate study i the field of petroleum geology leading to a master's degree. The stipend is $1,25 for a year's study plus $500 for books, field expenses, etc.

There are a number of assistantships available in the Department of Geology The stipend for half-time assistants is $1,350. Occasional appointments of quar ter-time assistants are made at a stipend of $675. Preference is given to appli cants who have had some graduate work and who are working for the Ph.D degree but superior students who have just completed the work for the bachelor's degree will also be considered. Application should be made to the Head of th Department, accompanied by a record of all undergraduate and/or graduate wor taken.

GRADUATE TEACHING FACULTY

Professors: G. W. White (Head of Department), C. A. Chapman, R. E. Grim, A. F. Hagner, J. L. Hough, H. W. Scott, P. R. Shaffer, H. R. Wanless.

Assistant Professors: D. M. Henderson, W. M. Merrill, F. H. T. Rhodes.

COURSES FOR GRADUATES

401. **Advanced Dynamic Geology.** A study of geologic processes and their effects. II; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Graduate standing in geology or in other departments allowing geology as a minor. Wanless.

402. **Advanced Historical Geology.** Principles of interpretation and problems of earth history. II; 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Graduate standing in geology or in other departments allowing geology as a minor. Wanless.

403. **History of Geology.** II; ½ to 1 unit. Offered in 1954-1955 and in alternate years. White.

409. **Sedimentation.** I; 1 unit. Prerequisite: Graduate standing in geology or related sciences. Wanless.

415. **Geology of the Upper Mississippi Valley.** Five or six two-day field trips; estimated expense, $60. I; 1 unit. Wanless.

422. **Stratigraphic Geology: Paleozoic.** I; 1 unit. Prerequisite: Geology 321. Scott.

423. **Stratigraphic Geology: Mesozoic and Cenozoic.** II; 1 unit. Prerequisite: Geology 321. Rhodes.

425. **Micropaleontology: Foraminifera.** Classification of microfossils, foraminifera; stratigraphic correlation. I; 1 unit. Prerequisite: Geology 320 or Zoology 320. Scott.

426. **Micropaleontology: Ostracoda.** Classification of microfossils, ostracodes, conodonts, scolecodonts, and other major groups, stratigraphic correlations. II; 1 unit. Prerequisite: Geology 320 or Zoology 320. Scott.

435. **Igneous Petrology.** The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory a study is made of selected rock suites, and special methods of petrographical investigation are covered. I; 1 unit. Chapman.

436. **Metamorphic Petrology.** Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied and special methods of investigation are covered. II; 1 unit. Chapman.

37. **Sedimentary Petrology.** II; 1 unit. Hough.

40. **Mineragraphy.** Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. I; 1 unit. Hagner.

43. **Mineral Deposits.** Principles of mineral deposition and genesis of mineral deposits. I; 1 unit. Prerequisite: Geology 311. Hagner.

44. **Mineral Deposits.** Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. II; 1 unit. Prerequisite: Geology 443. Hagner.

46. **Petroleum Geology: Principles.** I; 1 unit. Offered in 1955-1956 and in alternate years.

47. **Petroleum Geology: Fields.** A continuation of Geology 446. II; 1 unit. Offered in 1955-1956 and in alternate years.

50. **Geology for Civil Engineers.** Advanced physical geology, with emphasis on the geological aspects of civil engineering. I; 1 unit. Prerequisite: Geology 150 or equivalent. Hough.

51. **Mineralogy of Clays.** The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. I; 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. Grim.

52. **Mineralogy of Clays.** The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. II; 1 unit. Prerequisite: Geology 461. Grim.

91. **Research (Thesis).** Individual work under supervision of members of the staff in their respective fields. I, II; ½ to 4 units.

93. **Advanced Studies in Geology.** Supervised individual study. I, II; ½ to 2 units. Work may be taken in the following fields:

Clay Mineralogy. Grim.

Engineering Geology. Hough.

Geomorphology and Glacial Geology. Shaffer, White.

Ground-Water Geology.

Micropaleontology. Scott.

Mineral Deposits. Hagner.

Mineralogy and Crystallography. Henderson.

Paleobotany (see Botany 493). Stewart.

Paleontology. Scott.

Pennsylvanian Stratigraphy. Wanless.

Petrography and Petrology. Chapman.

Sedimentary Petrology. Wanless.

Stratigraphy. Decker, Scott.

URSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

1. **Geomorphology.** The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. I, II; 1 unit. Prerequisite: Geology 102. White.

1. **Structural Geology.** Rock deformation and its results. Lectures, laboratory, and field trip. I, II; 1 unit. Prerequisite: Geology 102.

5. **Field Methods.** Lecture, quiz, and field trips. Mapping of an area in southern Illinois. Credit is given only on completion of a satisfactory written report. II; ½ unit. Prerequisite: Geology 102. Wanless.

316. **Field Geology.** A field course covering structural, stratigraphic, glacial, an physiographic features. The emphasis is on methods of study and interpre tation. A comprehensive report is required to provide training in geologic report writing. Consult department office for dates of field trips; estimate travel expense, $60. Credit for course deferred until written report is sub mitted. S; 1 unit. Prerequisite: Geology 102 or equivalent; consent instructor.

317. **Geology of San Juan Region, Colorado.** Field course to be conducted fro campus of Fort Lewis Agricultural and Mechanical College near Durang Colorado. Field training in stratigraphy, structure, and geomorpholog Geologic mapping with plane table, and aerial photographs. S; 2 unit Prerequisite: Geology 102; consent of instructor. FISHER.

320. **Invertebrate Paleontology.** Fossil groups in biological sequence. Lectures an laboratory. I, II; 1 unit. Prerequisite: Geology 102. RHODES.

321. **Stratigraphy.** General stratigraphy, fossil faunas, with special reference invertebrates, and correlation. Emphasis is placed on the physical histor I, II; 1 unit. Prerequisite: Geology 320. SCOTT.

325. **Paleobotany. Same as Botany 325.** The structure, phylogeny, and geologic distribution of representative fossil plants. Two or three field trips. II; or 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite Botany 100 or Division of General Studies 131 and 132; Geology 101 consent of instructor. STEWART.

335. **Optical Mineralogy.** Study of the optical properties of minerals and the u of the petrographic microscope. Emphasis is on the identification of minera by the immersion method. Designed for students in geology, ceramic chemistry, mining, and agriculture. I; 1 unit. Prerequisite: Geology 13 CHAPMAN.

336. **Petrography.** Study of the constituents, composition, textures, structures, an classification of rocks. In the laboratory, rocks are studied in hand specim and thin section. Emphasis is on the ordinary methods of petrographic investigation. II; 1 unit. Prerequisite: Geology 335. CHAPMAN.

351. **Geophysical Prospecting.** Same as Mining Engineering 351. Principles geophysics and their application to mining processes. I; 1 unit. Prerequisit Consent of instructor. WUERKER.

354. **Mining Geology.** Same as Mining Engineering 354. Structure and occu rence of mineral deposits in relation to prospecting, exploration, developmen and exploitation. II; 1 unit. Prerequisite: Geology 101 or 150, 130 131, and Mining Engineering 201 or 230, or consent of instructor. CLAR

GERMAN

The Department of German offers graduate work leading to the degrees Master of Arts and Doctor of Philosophy. Students applying for admission mu have a 3.75 grade-point average for that portion of the work which represents t last fifty per cent of the hours completed to secure the bachelor's degree, excl sive of required physical education and military training. Students on limit status will not be admitted. Students should have completed a four-year cour of undergraduate study in German corresponding to the four-year course at t University. They should be familiar with the principal works of the writers of t classical and modern periods of German literature, possess a general knowled in the history of German letters and civilization, and be able to follow lectur in the German language. Acquaintance with German history, philosophy, and a

n their relation to the general European background is highly desirable. A eading knowledge of French is important and is required for advanced graduate vork. Also some fluency in Latin is recommended.

Fields of concentration for advanced degrees include German philology and inguistics, older literature, and modern literature. Such studies are greatly facili-ated by an excellent library collection which is particularly strong in German iterature from the seventeenth to the twentieth century. Special collections in-lude the following items: the German folksong collection (including the 'aticana), the John Meier collection, the Moritz Heyne collection in German hilology, the Armin Rattermann collection of German-Americana, the Bab-eldman collection in modern German drama, and many others.

Information on graduate course requirements and suggested readings may be btained from the graduate adviser, Professor Helmut Rehder, 211 Lincoln Hall.

Candidates for the degree of Master of Arts in the Teaching of German must arn four units in German, two units in education, and two units in electives. Requirements are German, two or two and one-half units to be chosen from the ollowing courses: German 301, 302, 311, 312, 315, 320, 331, or 332; one and ne-half to two units from German courses open only to graduates; education, two nits, including two of the following courses: Education 301, 302, 303, 304, one nit; and Education 311 and 312, one unit. The electives must be selected with the pproval of the adviser. The electives may be in German, in education, or, in xceptional cases, in other fields. The grade-point average required for admission the same as that required by the department. No limited status students will be dmitted to this program. The adviser for candidates for this degree is Professor Mimi I. Jehle, 217 Lincoln Hall.

ELLOWSHIPS

Information concerning fellowships may be obtained from the office of the raduate College. Students desiring graduate assistantships should apply directly the Department of German, 211 Lincoln Hall.

RADUATE TEACHING FACULTY

Professors: H. Rehder (Head of Department), J. R. Frey, E. A. Philippson, D. W. Schumann, H. Stegemeier.
Associate Professor: F. J. Nock.
Assistant Professors: F. G. Banta, Mimi I. Jehle.

OURSES FOR GRADUATES

00. **Beginning German for Graduate Students.** Introduction into the reading of German texts in the sciences and the humanities. Designed for graduate students desiring help in preparing for German reading requirements for the Ph.D. degree. I, II; 4 hours. No graduate credit. Nock.

01. **Readings in German for Graduate Students.** Designed for graduate students desiring help in preparing for the German reading requirements for the Ph.D. degree. I, II; 4 hours. No graduate credit. Prerequisite: German 400 or equivalent. Nock.

1. **Seminar.** Methods of literary criticism and research. I, II; ½ to 1 unit. Schumann.

5. **Middle High German.** I; 1 unit. Banta.

6. **History of the German Language.** II; 1 unit. Philippson.

6. **Gothic.** An introduction to Germanic (comparative) linguistics. II; 1 unit. Offered in 1955-1956 and in alternate years. Banta.

1. **German Literature of the Middle Ages.** German literature from 800 to 1400. I; 1 unit. Offered in 1955-1956 and in alternate years. Philippson.

432. **German Literature from 1400 to 1700.** Renaissance, Reformation, and Baroque in German literature. Lectures and readings. II; 1 unit. Offered in 1955-1956 and in alternate years. PHILIPPSON, REHDER.

441. **Modern German Literature.** I; 1 unit. Offered in 1954-1955 and in alternate years. SCHUMANN.

445. **Old High German.** Grammar and interpretation of the oldest literary documents. I or II; 1 unit. Offered in 1954-1955 and in alternate years. PHILIPPSON.

451. **German Romanticism.** Early romanticism. II; 1 unit. Offered in 1955-1956 and in alternate years. SCHUMANN.

458. **Intellectual Backgrounds of German Literature.** Social and philosophical currents reflected in German literature (eighteenth to twentieth century). II; 1 unit. Offered in 1954-1955 and in alternate years. REHDER.

460. **Seminar in German Literature.** Advanced research work in German literature; discussion of problems and papers. II; 1 unit. REHDER, SCHUMANN.

491. **Thesis.** I; ½ to 4 units. REHDER and staff.

492. **Thesis.** II; ½ to 4 units. REHDER and staff.

493. **Research in Special Topics.** I; ½ to 4 units. STAFF.

494. **Research in Special Topics.** II; ½ to 4 units. STAFF.

495. **Bibliography and Methods in Literary History.** To be taken concurrently with German 411. I; ½ unit. FREY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **German Literature to the Eighteenth Century.** I; 1 unit. Prerequisite: Three years of college German or equivalent. FREY.

302. **German Literature Since the Eighteenth Century.** II; 1 unit. Prerequisite: Three years of college German or equivalent. FREY.

303. **Advanced Composition and Syntax.** I or II; ½ unit. Prerequisite: Three years of college German, including German 212, or equivalent. JEHLE.

311. **Goethe.** Introduction to Goethe's life and works. I; 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Three years of college German. SCHUMANN.

312. **Goethe's Faust.** Intensive study of Goethe's Faust, Parts I and II. II; 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Three years of college German or equivalent. REHDER.

320. **History of German Civilization.** A selected topical, historical, and pictorial analysis of German culture and civilization. II; 1 unit. Prerequisite: Three years of college German or equivalent. STEGEMEIER.

331. **German Classics I.** Study of works of Lessing, Herder, and Wieland. I; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Three years of college German or equivalent. SCHUMANN.

332. **German Classics II.** Study of the works of Schiller, Kleist, Hölderlin, and Jean Paul. II; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Three years of college German or equivalent. SCHUMANN.

360. **Introduction to German Phonetics.** I; ½ unit. NOCK.

363. **Introduction to Comparative Literature.** Same as English 363. A comparative study of great books in Greek, Roman, Italian, and Spanish literature. I; ½ unit.

364. **Introduction to Comparative Literature.** Same as English 364. A comparative study of the great books in French, German, and English literature. II; ½ unit.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs has been established to develop a program of training for the public service, to provide in-service training for state and local government employees, to hold institutes and conferences for citizens and public officials, and to carry out a research program in the field of government and public affairs. The Institute serves as a planning and directing agency to correlate the work of existing colleges and departments in the field of public affairs. Royden Dangerfield is the Director.

ASSISTANTSHIPS

The Institute has available a limited number of part-time research assistantships for qualified students in the fields of political science, public administration, and economics. Applications should be addressed to the Director, 1209 West Illinois Street, Urbana.

HISTORY

The Department of History offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Professors C. E. Nowell and C. G. Starr form the department's committee in general charge of advising graduate students in history. Graduate work in history presupposes two years of college work in this subject, or sixteen semester hours, which should include courses in European and American history equivalent to History 111, 112, 151, and 152. Linguistic preparation, especially in French and German, is important. For ancient and medieval history some knowledge of Latin is essential. Spanish is useful for certain fields of American and Latin-American history.

Beginning graduate students admitted to full standing in the Department of History must have a grade-point average no lower than 3.5 for that portion of undergraduate work representing the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students may be admitted on limited status.

Graduate courses in history at the University of Illinois are of three kinds: (1) lecture courses providing information, interpretation, and guidance in general reading; (2) instruction in methodology, historiography, and bibliography (History 495 and 496 are required of all graduate students in history during their first year); (3) seminars for the study of special fields with a view to training in methods of historical criticism and research and in the writing and presentation of historical essays.

The following statement regarding the specific requirements for higher degrees in history conforms to the general requirements of the Graduate College.

Degree of Master of Arts. Shortly after his registration each candidate for this degree is required to take a comprehensive examination based on his undergraduate work in history. Questions are given in the following four fields of history: ancient, medieval and modern European, English, and American. Candidates must answer questions in three of four fields. Each candidate must have a reading knowledge of one foreign language, ordinarily French or German, as demonstrated by an oral examination administered by the department. Each candidate is expected to devote special attention to two of the following fields: ancient history, medieval history of continental Europe, modern history of continental Europe, English history, American history, Latin-American history, and the history of the Far East. Each candidate is also expected to write a master's thesis in one of his fields of specialization. By special permission he may sub-

stitute a third field for the thesis requirement. To constitute a field of specialization a minimum of two units of graduate study is ordinarily required.

Graduate study in history may also be pursued in connection with the degrees of Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see page 246).

Degree of Doctor of Philosophy. The candidate who selects history as his major subject should prepare himself for a preliminary examination in five fields, of which four are normally in history and one is in an outside related subject.

The preparation of the candidate should include a minimum of four units in the field of history in which he wishes to specialize and in which his thesis is to be written. This field constitutes his major.

There should be a minimum of three units in a second field known as the first minor, and two units each in three other fields. One of these, outside the department, constitutes the second minor.

The Department of History offers the following fields of specialization and preparation: ancient history, medieval history, continental Europe from 1300 to 1648 (Renaissance and Reformation), continental Europe and its dependencies since 1648, England and its dependencies, the United States, and Latin America. This enumeration of fields is not to be regarded as excluding the possibility of accepting others as may be determined by the department in individual cases.

The second minor field may be selected from the following departments and areas, although other suitable second minors may be arranged through consultation with department advisers:

Political Science. International law and diplomacy, modern government, municipal government, constitutional and administrative law and jurisprudence, political theory.

Economics and Sociology. Economic history, economic theory, public and private finance, social reform, principles of sociology.

Philosophy and Education. History of ancient and medieval philosophy, history of modern philosophy, history of education.

Literature. Some division of the history of literature, which may be either comparative literature of a limited period or the literature of a particular country for a more extended period as may be agreed upon in each case.

Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey, graduate students in the department are able to obtain useful training in the study of manuscript as well as printed materials.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor (three-unit field) in American literature, and the second minor (two-unit field) in the history of fine arts in the United States.

FELLOWSHIPS AND ASSISTANTSHIPS

The department awards annually to the ranking student in English or medieval history the Laurence M. Larson Memorial Fellowship, which represents the income from a fund of $5,000 set up in the will of Lillian D. Larson in memory of her husband, at one time Head of the Department of History.

The department participates with the Department of Political Science in the Kendric C. Babcock Fellowship established under the will of Dean Kendric C. Babcock. For the third year these appointments carry a stipend of $1,400 and postdoctoral grants carry a stipend of $2,400. Nominations for these fellowships are made by the heads of the departments of History and Political Science. Application forms may be obtained from the Graduate College office.

The department has available a number of teaching assistantships which

carry the requirement of six hours teaching a week in elementary sections. Before being considered for these appointments, students must have been in attendance in the Graduate College in the Department of History for at least a year, they must have done work of high distinction, and have received the master's degree. There are no formal application forms for applying for these appointments. Correspondence regarding them should be addressed to the Head of the Department. There are also certain research assistantships available. These are subject to the same general regulations as teaching assistantships.

GRADUATE TEACHING FACULTY

Professors: F. C. Dietz (Head of Department), A. E. Bestor, Jr., R. G. Bone, R. N. Current, E. L. Erickson, C. E. Nowell, R. S. Rodkey, F. A. Shannon, C. G. Starr, R. P. Stearns, J. W. Swain.

Associate Professor: J. B. Sirich.

Assistant Professors: J. L. Bates, Natalia M. Belting, W. J. Bouwsma, C. E. Dawn, Louise B. Dunbar, D. J. Geanakoplos, T. S. Hamerow, Mary L. Shay, R. M. Sutton.

COURSES FOR GRADUATES

409. **Seminar in Modern History: The Enlightenment.** I; 1 unit. Prerequisite: Reading knowledge of one major European language other than English. Stearns.

410. **Seminar in Modern History: The Enlightenment.** Variation of the topics treated in History 409 as student interest and ability (or previous work) necessitates. II; 1 unit. Prerequisite: Reading knowledge of one major European language other than English. Stearns.

411. **The French Revolution.** A seminar in the history of France and her relations with Europe, 1789 to 1799. I; 1 unit. Sirich.

412. **Napoleon.** A seminar in the history of France and her relations with Europe, 1799 to 1815. II; 1 unit. Sirich.

415. **Seminar in the History of Europe Since 1815.** I, II; 1 unit. Hamerow.

419. **Seminar in Modern Russian History.** I; 1 unit. Rodkey.

420. **Seminar in Modern Russian History.** II; 1 unit. Rodkey.

431. **Seminar in English History.** I; 1 unit. Dietz.

432. **Seminar in English History.** II; 1 unit. Dietz.

452. **Seminar in American History.** Introduction to research. I; 1 unit.

453. **Problems in the Social History of the United States Before 1860.** A seminar in the social and economic history of the United States before 1860. Students work on individual problems related to a general topic and give oral and written accounts in class of the progress and results of their research. I; 1 unit. Shannon.

454. **Problems in the Social History of the United States Since 1860.** A seminar in the social and economic history of the United States after 1860. Students work on individual problems related to a general topic and give oral and written accounts in class of the progress and results of their research. II; 1 unit. Shannon.

456. **Seminar in American Diplomatic History.** II; 1 unit. Current.

458. **Seminar in American History: The Revolutionary Period.** I, II; 1 unit. Dunbar.

472. **Seminar in the Intellectual History of the United States.** II; 1 unit. Bestor.

473. Graduate Survey of American History to 1865. I; 1 unit. Prerequisite: Two courses in American history at the 300 level. CURRENT.

474. Graduate Survey of American History Since 1865. II; 1 unit. Prerequisite: Two courses in American history at the 300 level. CURRENT.

475. Seminar in Latin-American History: The A.B.C. Powers and Mexico. I; 1 unit. NOWELL.

476. Seminar in Latin-American History: The Revolutionary Period. Studies in the history of Latin America during the first half of the nineteenth century; emphasizes research in special topics. II; 1 unit. NOWELL.

482. Seminar in Ancient History. I; 1 unit. SWAIN.

491. Research in Special Topics. Individual direction in research and guidance in writing theses for advanced degrees. I, II; 1 to 4 units. STAFF.

495. Historical Method. Required of all candidates for an advanced degree in history who do not present evidence of similar training elsewhere. I; 1 unit. BESTOR.

496. History of Historiography. II; 1 unit. SWAIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. The Middle Ages from 400 to 1100 A.D. Europe from the fall of Rome to the first crusade. I; ½ to 1 unit. GEANAKOPLOS.

302. The Middle Ages from 1100 to 1500 A.D. Europe from the rise of towns to the establishment of national monarchy. II; ½ to 1 unit. GEANAKOPLOS.

304. Medieval Civilization. Religious and intellectual. II; ½ to 1 unit. GEANAKOPLOS.

305. The Age of the Renaissance. I; ½ to 1 unit. BOUWSMA.

306. The Age of the Protestant and Catholic Reformation, 1500 to 1648. II; ½ to 1 unit. BOUWSMA.

307. Classical Islam: The Near East from Mohammed to the Crusades. I; ½ to 1 unit. DAWN.

308. The Europeanization of the Near East from 1768 to 1914. II; ½ to 1 unit. DAWN.

309. Development of Modern Europe, 1648 to 1798: Absolutism and Colonial Expansion. I; ½ to 1 unit. SIRICH.

310. The French Revolution and Napoleon, 1789 to 1815. II; ½ to 1 unit. SIRICH.

311. European History from 1815 to 1871. I; ½ to 1 unit. HAMEROW.

312. European History from 1871 to 1900. II; ½ to 1 unit. HAMEROW.

313. European History from 1900 to 1925. I; ½ to 1 unit. SHAY.

314. European History from 1925 to the Present. II; ½ to 1 unit. SHAY.

317. History of Modern Italy from 1700 to 1830. I; ½ unit. SHAY.

318. History of Modern Italy from 1831 to the Present. II; ½ unit. SHAY.

322. History of Spain and Portugal. A survey of the Iberian Peninsula from the earliest times until the present. I; ½ to 1 unit. NOWELL.

323. Science, Philosophy, and the Modern European Mind. Intellectual history of modern Europe from 1543 to 1770. I; ½ to 1 unit. Prerequisite: One year of college history. SIRICH, STEARNS.

324. Science, Idealism, and Materialism. Intellectual history of modern Europe from 1770 to 1914. II; ½ to 1 unit. Prerequisite: One year of college history. SIRICH, STEARNS.

325. Intellectual and Cultural History of Russia to 1881. I; ½ to 1 unit. RODKEY.

26. **Intellectual and Cultural History of Russia from 1881 to the Present.** II; ½ to 1 unit. Rodkey.

27. **The Russian Revolution.** I; ½ to 1 unit. Rodkey.

28. **History of Soviet Russia from 1917 to the Present.** II; ½ to 1 unit. Rodkey.

33. **History of England from 1377 to 1485.** I; ½ to 1 unit. Offered in 1955-1956 and in alternate years. Dietz.

34. **The History of England Under the Tudors, 1485 to 1603.** II; ½ to 1 unit. Offered in 1955-1956 and in alternate years. Dietz.

35. **Foundations of English and American Democratic Institutions from 1603 to 1689.** I; ½ to 1 unit. Stearns.

36. **Development of English and American Democratic Institutions from 1689 to 1783.** II; ½ to 1 unit. Stearns.

39. **History of the British Commonwealth in the Nineteenth Century, 1783 to 1900.** I; ½ to 1 unit. Prerequisite: One year of college history. Erickson.

40. **History of the British Commonwealth in the Nineteenth Century, 1901 to the Present.** II; ½ to 1 unit. Prerequisite: One year of college history. Erickson.

43. **Social and Economic History of England Since the Beginning of the Industrial Revolution.** Social and economic history of England from 1750 to 1848. I; ½ to 1 unit. Offered in 1954-1955 and in alternate years. Dietz.

44. **Social and Economic History of England Since the Beginning of the Industrial Revolution.** Social and economic history of England since 1848. II; ½ to 1 unit. Offered in 1954-1955 and in alternate years. Dietz.

45. **Constitutional History of England to 1485.** I; ½ to 1 unit. Dietz.

46. **Constitutional History of England from 1485 to the Present.** II; ½ to 1 unit. Dietz.

49. **The Age of Discovery.** I; ½ to 1 unit. Nowell.

52. **Colonial Beginnings of American Life and Institutions: A Study of the Seventeenth and Eighteenth Century Colonies.** I; ½ to 1 unit. Dunbar.

54. **The Era of the American Revolution, 1763 to 1789.** II; ½ to 1 unit. Prerequisite: One year of college history. Dunbar.

57. **Social and Economic History of the United States from 1775 to 1860.** The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. I; ½ to 1 unit. Prerequisite: One year of college history. Shannon.

58. **Social and Economic History of the United States Since 1860.** The growth of American economic life and institutions since 1860. II; ½ to 1 unit. Prerequisite: One year of college history. Shannon.

59. **The Civil War and Reconstruction.** Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. I; ½ to 1 unit. Shannon.

61. **History of the United States from 1877 to 1917.** I; ½ to 1 unit. Bates.

62. **History of the United States Since 1917.** II; ½ to 1 unit. Bates.

63. **History of the West from 1634 to 1774.** I; ½ unit. Belting.

64. **History of the West from 1774 to 1830.** II; ½ unit. Belting.

65. **History of Illinois from 1809 to the Present.** Evolution of a typical middle western commonwealth. II; ½ unit. Sutton.

69. **Constitutional Development of the United States to 1865.** I; ½ to 1 unit. Bestor.

370. **Constitutional Development of the United States Since 1865.** II; ½ to 1 unit. Bestor.

371. **American Intellectual and Cultural History to 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. I; ½ to 1 unit. Bestor.

372. **American Intellectual and Cultural History Since 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. II; ½ to 1 unit. Prerequisite: History 371. Bestor.

373. **Diplomatic History of the United States to the End of the Nineteenth Century.** I; ½ to 1 unit. Current.

374. **Diplomatic History of the United States in the Twentieth Century.** II; ½ to 1 unit. Current.

375. **History of Latin America to 1824.** A survey of Latin-American history from the discovery of America until 1824. I; ½ to 1 unit. Nowell.

376. **History of Latin America Since 1824.** A history of the Latin-American republics from their independence to the present. II; ½ to 1 unit. Nowell.

377. **History of the A.B.C. Powers.** History of Argentina, Brazil, and Chile from their origins to the present. I; ½ unit. Nowell.

378. **History of the Caribbean Area.** A survey of the Caribbean, Mexico, and Central America from the discovery of America to the present. I, II; ½ unit. Nowell.

381. **Ancient Greek States.** History of the Greek States from the earliest times to 334 B.C. I; ½ to 1 unit. Swain.

382. **Ancient Imperialism.** Alexander and his successors. II; ½ to 1 unit. Swain.

383. **The Roman Republic.** History of the Roman Republic to 44 B.C. I; ½ to 1 unit. Swain.

384. **Ancient Imperialism.** The Roman Empire. II; ½ to 1 unit. Swain.

391. **History of Eastern Asia to 1839.** History of eastern Asia (China, Japan, and Korea) to 1839. I; ½ unit.

392. **History of Eastern Asia Since 1839.** History of eastern Asia (China, Japan, and Korea) since 1839. II; ½ unit.

HOME ECONOMICS

The Department of Home Economics offers graduate work leading to the degrees of Master of Science or Master of Arts in Home Economics. The major work may be done in one of five curricula: child development and family relationships, family housing and household management, foods and nutrition, general home economics, or textiles and clothing. The degree of Master of Science in Home Economics Education is granted to those students who take their major work in the field of home economics education.

Students who elect home economics as their major subject for a master's degree should have complied with the undergraduate requirements of the specific field of concentration selected or should have had equivalent training. To be admitted with full status the grade-point average for that portion of work representing the last fifty per cent of undergraduate work must be at least 3.5, exclusive of required courses in physical education and military training. Students on limited status are accepted. All candidates for a master's degree in home economics must take a minimum of eight units. If a thesis is not to be

submitted, a minimum of nine units must be taken. In either case at least four of these units are to be in home economics. Four units, either in home economics or electives, are to be courses numbered 400 or above.

Recommended home economics courses, suggested electives, and special requirements for each of the five curricula are as follows:

(1) *Child Development and Family Relationships.* Four units from Home Economics 301, 305, 410, 481, 482, 493, 494, and four units from Anthropology 361; Education 317, 431; Psychology 436, 461; Social Work 451, 452; Sociology 412, 420, 481; or Speech 385.

(2) *Family Housing and Household Management.* Two and one-half units from Home Economics 361, 378, 493, 494, and Agricultural Engineering 393. Additional units to complete the requirement of at least four in home economics from Home Economics 301, 375, 377, 379, 380, 388, 389, 410, 481, 482. Four units may be selected from Agriculture 400; Agricultural Economics 341, 497; Economics 378, 379, 380; Education 453; Sociology 400, 477.

(3) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 423, 481, 482, 493, 494. Four units may be selected from Animal Nutrition 401, 402, 405, 407, 408; Bacteriology 308, 309; Chemistry 352, 421, 426, 450, 452; or Physiology 306, 307. (Chemistry 350 and 354 or 355, or 240 and 241 are required.)

(4) *General Home Economics.* Four units from prescribed courses in three of the following curricula: (1), (2), (3), or (5). Additional units may be taken in home economics, economics, education, psychology, or sociology.

(5) *Textiles and Clothing.* Three units from Home Economics 380, 386, 388, 389, 395, 482, 493, 494, and one additional unit in home economics. Four units may be taken in related fields and courses: Art; Marketing 401, 402, 407, 421; Economics 400, 401, 436, 437; Psychology 441; Sociology 422, 444, 476, 477, 481.

Graduate students who choose home economics as their minor for the degree of Doctor of Philosophy must have adequate preparation in home economics, and must complete three units for a first minor or two units for a second minor, in addition to credit offered for the master's degree. At least one unit must be taken in courses numbered above 400.

Candidates for the degree of Master of Science in Home Economics Education must earn eight units as follows: home economics, two to two and one-half units; education, three and one-half to four units; electives, two units. The requirements are (1) two to two and one-half units of home economics chosen from courses in home management (Home Economics 361, 375, 378, 379), foods and nutrition (Home Economics 320, 322, 323, 326, 330, 331), textiles and clothing (Home Economics 380, 386, 388, 389, 395, 482), child development and family relationships (Home Economics 301, 378, 379, 410, 481, 482); (2) Education 311 and 312, one unit; (3) two of the following courses: Education 301, 302, 303, 304, one unit; (4) Education 453, one unit; (5) Education 456, one unit, or Home Economics 377, one-half unit. The elective courses must be selected with the approval of the advisers. Professor Janice M. Smith, Head of the Department of Home Economics, 109 Bevier Hall, and Professor Letitia Walsh, 102 Gregory Hall.

ASSISTANTSHIPS

There are part-time research and teaching assistantships available in the various areas of home economics. An applicant should have a satisfactory scholastic record and strong professional interest in the area. Applications should be sent to Professor Janice M. Smith, Head of the Department of Home Economics, 109 Bevier Hall. To be considered, applications must be received by March 1 prior to the academic year for which an assistantship is desired.

GRADUATE TEACHING FACULTY

Professors: Janice M. Smith (Head of Department), Kathryn V. Burns, D. G. Carter, Nellie L. Perkins, Frances O. Van Duyne.

Associate Professors: Harriet T. Barto, Margaret R. Goodyear, Pearl Z. Janssen, Florence M. King, E. Evelyn Smith, Jane Werden.

Assistant Professors: Marian T. Childs, J. V. Craig, Helen E. McCullough, Beula V. McKey, Ritta Whitesel.

Instructor: Catherine M. Sullivan.

COURSES FOR GRADUATES

410. **Problems in Family Living.** Family relationships and their significance to the growth of family members. I or II; 1 unit. Prerequisite: Sociology 220 or its equivalent and consent of instructor. Perkins.

423. **Problems in Human Nutrition.** Methods of assessing nutritional status of humans. II; ½ to 1 unit. Prerequisite: Home Economics 324 or equivalent. J. M. Smith.

481. Seminar.
   (a) **Child Development and Family Relationships.** Emphasis on the child. Advanced problems. I; 1 unit. Prerequisite: Undergraduate courses in child development. Perkins.
   (b) **Nutrition.** I; ½ unit. J. M. Smith.

482. Seminar.
   (a) **Child Development and Family Relationships.** Emphasis on the family. Advanced problems. II; 1 unit. Prerequisite: Home Economics 410. Perkins.
   (b) **Foods.** Study and discussion of recent research. II; ½ unit. Van Duyne.
   (c) **Textiles and Clothing.** II; ½ to 1 unit. King.

493. **Research.** Work may be taken in the following subjects: (a) the child and the family, (b) family housing, (c) foods, (d) nutrition, (e) textiles and clothing. I; ½ to 3 units. Carter, Childs, King, Perkins, J. M. Smith, Van Duyne, Werden.

494. **Research.** Work may be taken in the following subjects: (a) the child and the family, (b) family housing, (c) foods, (d) nutrition, (e) textiles and clothing. II; ½ to 3 units. Carter, Childs, King, Perkins, J. M. Smith, Van Duyne, Werden.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Problems in Home Guidance of Children.** Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. I, II; ½ to 1 unit. Prerequisite: Home Economics 201 and 202; consent of instructor. Perkins.

305. **Human Heredity.** Heredity in man and its relation to various individual and social problems. Lectures, discussions, and demonstrations. I; ½ unit. Graduate credit does not count toward a major in genetics. Craig.

320. **Diet in Disease.** Readings, reports, and laboratory experience with therapeutics. I, II; ½ unit. Prerequisite: Home Economics 220. Barto.

322. **Physical Growth and Nutrition.** Lectures, readings, and discussions. I; ½ unit. Prerequisite: Home Economics 220; consent of instructor. J. M. Smith.

323. **Recent Advances in Foods and Nutrition.** New developments in foods and nutrition through readings, lectures, and discussions. S; ½ unit. Prerequisite:

Chemistry 132 or 133; Physiology 103 or 110; Home Economics 131 and 220. CHILDS, VAN DUYNE.

24. **Problems in Nutrition.** Discussions and investigations. II; ½ to 1 unit. Prerequisite: Home Economics 220; Chemistry 350. CHILDS.

26. **Demonstration Problems and Techniques.** Consideration of the techniques of demonstrations and problems involved. S; ½ unit. Prerequisite: One of the following: Home Economics 232, 262, 272, 301, 379, 380, 386, or consent of instructor. JANSSEN.

30. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. I, II; ½ unit. Prerequisite: Home Economics 232; Bacteriology 104. JANSSEN.

31. **Problems in Foods.** Applications of chemical and physical principles to advanced food problems. II; ½ unit. Prerequisite: Home Economics 330. VAN DUYNE.

45. **Institution Management.** Purchase of food supplies and equipment for institutions; grades of food, judging of quality and cost in relation to season, pure food laws and government inspection; the storeroom and its management; equipment and furnishing; institution housekeeping, floor plans and routing; specifications for equipment; inventory of equipment; visits to stores and markets. I; ½ unit. Prerequisite: Credit or registration in Home Economics 240 and Economics 108; consent of instructor. E. E. SMITH.

50. **Institution Dietaries and Administration.** Dietary studies and menu making for various types of institutions, such as dormitories, cafeterias, hospitals, and tearooms; problems of organization, personnel studies, administration of food service, records and cost accountings, professional ethics. Opportunity is given for observation and practice in various fields. Field trip is required; estimated expense, $50. II; ½ to 1 unit. Prerequisite: Home Economics 220 and 240; consent of instructor. E. E. SMITH.

351. **Special Problems on Group Feeding with Emphasis on the School Lunch.** Planned for teachers in secondary schools and for home advisers and others interested in community feeding problems. Lectures, discussions, and laboratory practice in quantity food management. Emphasis on the school lunch program as an integral part of the educational system. Special problems in purchasing, floor plans, and equipment are required of graduate students. No credit for students who have had Home Economics 350 or 355. S; ½ unit. Prerequisite: Home Economics 220, 232, or equivalent; consent of instructor. Food handler's certificate required. E. E. SMITH.

355. **Advanced Quantity Cookery and Catering.** Planned for students in the restaurant management curriculum and for other qualified students. Practice in menu making and aspects of management necessary for special catering functions and meal projects. Special lectures and demonstrations emphasizing the artistry of preparation, serving, and merchandising of quality food. Supervised practice in various food service units. Field trips and special assignments. II; ½ unit. Prerequisite: Home Economics 350; consent of instructor. E. E. SMITH.

361. **Development and Function of Family Housing.** Same as Agricultural Engineering 361. Study of principles and problem solutions in family housing: basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. II; ½ unit. Prerequisite: Home Economics 272 or consent of instructor. CARTER.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment

and equipment performance tests. S; ½ unit. Prerequisite: Home Economics 272; six advanced hours (Group III courses) in home economics; consent of instructor. SULLIVAN.

377. **Home Economics Extension.** History and development; types of county organizations; objectives; extension teaching tools; county program determination and evaluation. Field trips. II; ½ to 1 unit. Prerequisite: Consent of instructor. BURNS.

378. **Problems in Home Management.** Individual investigation and reports of specific problems in the field of home management. I; ½ unit. Prerequisite: Home Economics 272; consent of instructor. GOODYEAR, MCCULLOUGH, PERKINS.

379. **Problems in Home Management.** Individual investigation and reports of specific problems in the field of home managemnet. II; ½ unit. Prerequisite: Home Economics 272; consent of instructor. GOODYEAR, MCCULLOUGH, PERKINS.

380. **Textiles.** Textiles from the economic, artistic, physical, and chemical viewpoints. I; ½ unit. Prerequisite: Home Economics 180; Chemistry 132; Economics 108; consent of instructor. KING.

386. **Clothing Design and Construction.** Problems in creating original designs, developing a more thorough understanding of the figure through design adaptation. Emphasis on adaptability to fabric draping or flat pattern construction. Investigation of sources of inspiration and relationship to significant trends in design. II; 1 unit. Prerequisite: Home Economics 285 and 286. KING, WHITESEL.

388. **Problems in Textiles and Clothing.** Investigation and report of specific problems in the field of textiles and clothing. I; ½ unit. Prerequisite: Home Economics 286 or 380; consent of instructor. Each student undertakes an individual problem which in some cases may involve prerequisites in chemistry and physics. KING, WERDEN, WHITESEL.

389. **Problems in Textiles and Clothing.** Investigation and report of specific problems in the field of textiles and clothing. II; ½ unit. Prerequisite: Home Economics 286 or 380; consent of instructor. Each student undertakes an individual problem which in some cases may involve prerequisites in chemistry and physics. KING, WERDEN, WHITESEL.

395. **Fashion Analysis.** Factors affecting design, production, distribution, promotion, and trends in fashion development; forecasting methods of measurement and prediction; price levels — relation to fashion cycle and quality in design and workmanship. II; ½ unit. Prerequisite: Consent of instructor. KING.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy degrees. Candidates may specialize for either degree in floriculture, plant breeding, plant pathology, pomology, or vegetable crops.

The department requires a grade-point average of 3.75 for that portion of work which represents the last fifty per cent of the hours completed for the bachelor's degree, exclusive of required physical education and military training, and will not accept students on limited status.

Twenty hours of undergraduate work in horticulture and allied subjects are required of students who choose horticulture as a major, and twelve hours are

equired of those who select it as a minor. The department will waive certain f these requirements for some fields of major study if the student has had an quivalent preparation in the fundamental sciences. It is desirable, when the najor field of study is decided upon during the junior or senior year, to select he fundamental science courses accordingly and, if possible, to include in the ndergraduate preparation the elementary courses in German or French.

Advanced work in botany, chemistry, entomology, agronomy, genetics, or gricultural economics may be taken advantageously with horticulture to make well-balanced course of graduate study.

GRADUATE TEACHING FACULTY

Professors: C. J. Birkeland (Head of Department), A. S. Colby, D. Gottlieb, W. A. Huelsen, M. B. Linford, M. B. Linn, R. V. Lott, D. Powell, F. F. Weinard.

Associate Professors: C. Y. Arnold, J. R. Kamp, V. W. Kelley, J. P. McCollum, H. H. Thornberry.

Assistant Professor: A. E. Thompson.

COURSES FOR GRADUATES

04. **Plant Virology.** Same as Botany 404 and Plant Pathology 404. Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, staining, assay, filtration, and purification; control methods; sources of information; history of virology. II; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Consent of instructor. Thornberry.

417. **Discussions in Plant Pathology.** Same as Botany 417 and Plant Pathology 417. Required for majors in plant pathology and as elective for graduate students in plant science. I, II; ¼ unit. Staff.

424. **Advanced Plant Virology.** Same as Plant Pathology 424. Purification and special properties of virus nucleoproteins or selected virus diseases are considered. Different specific topics for concentrated study may be selected for subsequent semesters depending upon the student's interest. A specific topic pertinent to the student's thesis problem may be selected. Theories and original data are to be critically analyzed and evaluated. II; ½ to 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Horticulture 404; consent of instructor. Thornberry.

447. **Horticulture Seminar.** Discussion of current research and literature pertaining to problems of horticulture and related fields. I, II; ¼ unit. Staff.

464. **Advanced Small Fruit Culture.** Detailed studies of varietal classification, growth, and fruiting habits, and the effects of cultural practices on production. The results of recent research with small fruits both in the station experimental plots and elsewhere are used as a basis for the work. II; ½ to 1 unit. Colby.

491. **Thesis.** Research on the thesis problem in floriculture, fruit breeding, plant pathology, pomology, and vegetable crops. I, II; ½ to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Required of horticulture majors.

493. **Research.** Research on problems in floriculture, fruit breeding, plant pathology, pomology, and vegetable crops. I, II; ½ to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Required in major or minor in horticulture.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Fruit Diseases.** Same as Botany 307 and Plant Pathology 307. Symptomatology; laboratory and field studies of representative diseases; control measures. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Botany 317 or 372. Powell.

308. **Vegetable and Canning Crop Diseases.** Same as Botany 308 and Plant Pathology 308. Symptomatology; laboratory and field studies of representative diseases; control measures. II; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Botany 317 or 372. Linn.

317. **Plant Pathology.** Same as Agronomy 317, Botany 317, and Plant Pathology 317. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science, including Botany 100. Black.

321. **Floricultural Physiology.** Plant hormones, effect of light, temperature, humidity, and gases on growth of ornamental plants; principles of disease and insect control. Lectures, assigned readings, discussion. I; ½ unit. Prerequisite: Botany 130. Weinard.

322. **Plant Nutrition.** Soil conditions in relation to the growth of ornamental plants; soil and plant tissue tests, fertilizers and their use; soilless culture; water supplies and automatic watering. Lectures, assigned readings, discussions. II; ½ unit. Prerequisite: Botany 130; Agronomy 201. Weinard.

333. **Marketing Horticultural Products.** Same as Agricultural Economics 333 and Marketing 333. Producing and consuming areas; transportation; refrigeration; agencies, functions, and channels of distribution; cooperatives; marketing costs and factors affecting prices; standardization, grading, and inspection; marketing news service; perishable agricultural commodity act and other regulations; attempts to control surpluses; canning and other processing; foreign trade; consumer preference and expansion of domestic markets. I; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or five hours of horticulture, or consent of instructor. Kelly.

345. **Growth and Development of Vegetable Crops.** Factors affecting growth, development, and quality of vegetable crops. Discussions. I; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Botany 130 or consent of instructor; senior standing. McCollum.

367. **Morphological, Anatomical, and Physiological Characteristics of Fruits.** Lecture, discussion, laboratory, and reference reading. The major morphological, anatomical, and physiological characteristics of fruit species and varieties. I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Horticulture 161, Botany 130, Chemistry 132; or consent of instructor. Lott, Simons.

379. **Research Methods in Plant Pathology.** Same as Agronomy 379, Botany 379, and Plant Pathology 379. Lectures and laboratory techniques for isolation, for culture of and inoculation with plant pathogens, for evaluation of plant protectants; for the study of the physiology of parasitism and methods of evaluation of data and preparation of manuscripts. I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Horticulture 317. Gerdemann, Gottlieb.

382. **Improvement of Horticultural Crops by Breeding.** Mechanism of hereditary variations and varietal differentiation in horticultural plants as a basis for determining the method of approach to crop improvement problems, with emphasis on asexually propagated crops. II; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Horticulture 110 or equivalent. Thompson.

HUMANITIES

The Division of the Humanities is composed of the departments of Classics, English, French, German, History, Philosophy, Spanish and Italian, and Speech. It sponsors several courses of interdepartmental interest and purpose, serving the Liberal Arts and Sciences requirement in general education. Its teaching faculty consists of the full-time faculties of the departments listed, of the rank of instructor and above. Professor C. G. Starr is Chairman of the Division.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Linguistics.** An introduction to the science of descriptive linguistics. I; 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

302. **Comparative Linguistics.** An introduction to the historical aspects of language. II; 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. HELLER.

JOURNALISM AND COMMUNICATIONS

Graduate work is offered in the following fields: editorial, advertising, and radio-television. The program of graduate study in these areas is limited to the Master of Science degree. For the program leading to a Doctor of Philosophy degree in Mass Communications, see page 184.

Admission to the graduate program is based on the following: (1) Completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major in journalism, English, or the social sciences. A major normally consists of twenty semester credits. (2) A grade-point average of at least 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required courses in physical education and military.

Requirements for the degree of Master of Science include the following:

(1) A major in editorial, advertising, or radio-television consisting of four units, or three units in journalism and communications and one additional unit approved by the Graduate College, including:

(a) For editorial majors, at least two units from Journalism 471, 473, and 474. Candidates in the editorial field who do not present an acceptable undergraduate major in journalism will be required to complete Journalism 311, 321, and 323 for the master's degree.

(b) For advertising majors, at least two units from Journalism 471, 481, and 482. Candidates in the advertising field who do not present an acceptable undergraduate major in journalism will be required to complete Journalism 382, 383, and 384 for the master's degree.

(c) For radio-television majors, at least one unit from Journalism 462 or 471. Candidates in the radio-television field who do not present an acceptable undergraduate major in journalism will be required to complete Journalism 252, 368, and 386 for the master's degree.

(2) A minor of at least two units in a subject other than journalism.

(a) For editorial majors, the recommended fields are economics, English, history, philosophy, political science, psychology, and sociology.

(b) For advertising students, the recommended fields are marketing, economics, home economics, psychology, and sociology.

(c) For radio-television students, the recommended fields are psychology, economics, sociology, political science, and speech.

(3) A thesis, which may be for one or two units.

(4) A minimum total of eight units.

FELLOWSHIPS AND ASSISTANTSHIPS

Graduate students in journalism may apply for graduate fellowships. The stipend is $900 and tuition for first-year graduate students. Appointments are made by the Graduate College. No work requirements are attached to these awards. Selection is based on character, scholarship, and promise of success.

The International Circulation Managers' Association awards annually two fellowships of $750 each to graduates in journalism who intend to continue their education. Information concerning the fellowships may be obtained from H. Phelps Gates, *Christian Science Monitor,* Boston, head of the association committee which makes the awards.

Graduate assistantships are offered to outstanding college graduates with newspaper, radio, television, or advertising experience. These awards carry a stipend of $675 to $1,350 an academic year, plus tuition. The work requirement is ten to twenty clock hours a week.

Holders of assistantships can complete the requirements for a master's degree in three semesters or two semesters and one summer session. Assistants will be expected to teach laboratory classes in basic courses of the field of their experience or handle paper grading in other courses as directed.

GRADUATE TEACHING FACULTY

Professors: F. S. Siebert (Director of the School of Journalism and Communications), R. R. Barlow, L. W. Murphy, C. H. Sandage, W. Schramm.

Associate Professors: D. E. Brown, L. W. McClure, F. E. Schooley, J. T. Trebilcock, N. Wedding.

Assistant Professor: J. C. Sutton.

Instructors: H. V. Cordier, I. R. Merrill, T. B. Peterson, R. L. Rider, H. W. Sargent.

Lecturer: H. J. Skornia.

COURSES FOR GRADUATES

450. **Special Problems in Television.** Project work for advanced students in specific areas of television including news, advertising, directing, writing, etc. I, II; 1 to 2 units. Students may re-register for this course up to a total of four units. Prerequisite: A television course in the area of specialization; consent of instructor.

451. **Television Program Management and Production.** Problems in originating, planning, and producing television programs. II; 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor.

462. **Seminar in Radio and Television.** Same as Mass Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. II; 1 unit. Skornia.

471. **Theory of Communications.** Same as Mass Communications 471. Nature of the communication process; development of communication patterns and institutions; principles governing the control and support of mass communications; content and audience study; effects of communication; and relation of mass communications to public opinion and group action. I; 1 unit. Schramm.

73. **History and Theory of Freedom of the Press.** Same as Mass Communications 473. Development of the Anglo-American press system; philosophical bases of competing press systems. I; 1 unit. SIEBERT.

74. **Government and Mass Communications.** Same as Mass Communications 474. Current legal, constitutional, and administrative problems of media of mass communications; contemporary issues resulting from the restrictive, regulatory, and supplementary activities of government in the field of mass communications. II; 1 unit. SIEBERT.

81. **Advanced Advertising Principles.** Same as Mass Communications 481 and Marketing 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. SANDAGE.

82. **Research Methods in Advertising and Communications.** Same as Mass Communications 482 and Marketing 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both non-quantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

90. **Research in Special Topics.** Same as Mass Communications 490. I, II; ½ to 1 unit. Students may re-register for a total of 2 units. Prerequisite: Consent of instructor. STAFF.

92. **Thesis.** I, II; 1 to 2 units. Prerequisite: Graduate standing in journalism. SANDAGE, SCHRAMM, SIEBERT, SKORNIA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

08. **High School Journalism.** Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. II; ½ unit. Prerequisite: Education 211 or consent of instructor. BROWN.

09. **Public Relations.** Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. I; ½ unit. Prerequisite: Consent of instructor. MURPHY.

10. **Press Systems of the World.** Press of England, France, Germany, Italy, Russia, Latin America, China, and Japan; international organization of the press. II; ½ unit. BARLOW.

11. **Newspaper Law.** Freedom of the press; the right to gather, publish, and comment on the news. I, II; ½ unit. TREBILCOCK.

20. **Editorial Studies and Writing.** Writing of editorials and preparation of editorial judgments. Policies for editorials and for the editorial page. I; ½ unit. Prerequisite: Journalism 212. BARLOW.

21. **Copyreading.** Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and makeup and design of newspaper pages. I, II; 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212. SUTTON.

23. **Advanced Reporting.** Advanced types of news investigation and treatment. I, II; ½ unit. Prerequisite: Journalism 212 or equivalent. TREBILCOCK.

28. **Industrial Publications.** Problems and techniques of editing house organs. II; ½ unit. Prerequisite: Journalism 211 or 227. PETERSON.

43. **Newspaper Circulation Problems.** Study of the promotion, sales, distribution, and administration problems of the circulation departments of weekly and daily newspapers. II; ½ unit. Prerequisite: Journalism 241.

51. **Graphic Production Processes.** Detailed study of the preparation of copy and illustrative material for the mass production of news, features, and adver-

tising; comparison of quality and costs of production processes; consideration of personnel, equipment, and raw materials entering into graphic production. Field trips to Danville and Chicago; estimated expense, $15. II; ½ unit. Prerequisite: Journalism 204.

353. **Television Script Writing.** General principles of writing for television, including all non-dramatic and dramatic forms. I, II; ½ unit. Prerequisite: Journalism 252; consent of instructor.

354. **Television Directing.** The theory and techniques of directing the television program. Experience in directing laboratory productions. II; ½ unit. Prerequisite: Journalism 252; consent of instructor. RIDER.

355. **Television News.** News coverage, script preparation, use of visual materials and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. II; ½ unit. Prerequisite: Consent of instructor.

356. **Cinematography for Television.** The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. II; ½ unit. Prerequisite: Consent of instructor. PUTNAM.

362. **Radio and Television Station Management.** A study of the organization and administration of the radio staff and station; public relations, personnel management, and station operation; analysis of station and agency relationships and radio sales procedure; methods and media for program and station promotion; regulations affecting management, financing, and labor relationships. II; ½ unit. Prerequisite: Journalism 261. SCHOOLEY.

365. **Radio News.** News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. I, II; ½ unit. Prerequisite: Journalism 211. BROWN.

366. **Advanced Radio and Television Practices, I.** Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. I; ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. **Advanced Radio and Television Practices, II.** Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. II; ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. **Radio and Television Regulation.** Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. II; ½ unit. SIEBERT.

382. **Advertising Copy and Layout.** Same as Marketing 382. Theory and practice of advertising copy writing and layout for newspaper, magazine, and direct mail; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. I, II; 1 unit. Prerequisite: Journalism 204 and 281. SARGENT.

383. **Advertising Media.** Same as Marketing 383. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. I, II; ½ unit. Prerequisite: Journalism 281.

384. **Advertising Campaigns.** Same as Marketing 384. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of ad-

vertisements — copy and layout. I, II; ½ unit. Graduate students will not receive credit for both Journalism 384 and 387. Prerequisite: Journalism 382 or 282; Journalism 383. WEDDING.

385. **Advertising Promotion and Sales.** Same as Marketing 385. Sales problems, advertising promotion, advertising research, market research. I, II; ½ unit. Prerequisite: Journalism 281. MCCLURE.

386. **Radio and Television Advertising.** Same as Marketing 386. Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. I, II; ½ unit. Prerequisite: Journalism 281. SANDAGE.

387. **Advertising Policies and Problems.** Same as Marketing 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Consideration given to management problems at both the national and retail levels. I, II; ½ to 1 unit. Graduate students will not receive credit for both Journalism 384 and 387. Prerequisite: Journalism 281. WEDDING.

390. **Economics of Communications, I.** Same as Economics 390 and Mass Communications 390. Economic problems associated with the various forms of radio broadcasting including FM, television, and facsimile, and the use of radio for the safety and efficiency of transportation, protective services, etc. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

391. **Economics of Communications, II.** Same as Economics 391 and Mass Communications 391. Economic problems associated with the following means of communications: motion pictures, newspapers, magazines, and books. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

LABOR AND INDUSTRIAL RELATIONS

The Institute offers a degree of Master of Arts in Labor and Industrial Relations through an integrated curriculum of the social sciences which apply to this field. Institute courses are also available to the student working for the Master of Arts, Master of Science, or Doctor of Philosophy degrees in other departments of the University.

Students applying for admission must have a grade-point average of at least 3.5 for that portion of the work which represents the last fifty per cent of the hours earned toward the bachelor's degree exclusive of required courses in physical education and military training. Students on limited status will not be admitted.

The Institute's study program is based on the student's need for an understanding of the broad social and economic factors shaping our industrial society, some degree of specialization, and opportunities for practical experience in the field.

Students are admitted to the Institute on approval of the Director and upon presenting a minimum of twenty-one hours in the social sciences, of which six should be in economics other than statistics. Other social sciences include history, philosophy, political science, psychology, and sociology. At least three hours credit in statistics and three hours credit in labor economics or labor problems are to be included in the total of twenty-one hours.

Students who can not meet these special course prerequisites may register for graduate work, but must remove any deficiency during the first year of residence by taking the prescribed courses without graduate credit, unless exempted for reasons satisfactory to the adviser in charge.

A candidate for the Master of Arts degree in Labor and Industrial Relations must complete eight units of graduate credit including one unit in the Research Seminar in Labor and Industrial Relations (Labor and Industrial Relations 493), five units to be selected from appropriate courses, and two units devoted to the writing of a thesis.

With the approval of the Institute, courses to meet the five-unit requirement may also be selected from those offered in other departments of the University.

In addition to the eight units described above, the student must have a work experience for a minimum of three months. The student must show — through oral and written examinations — that he has an understanding of the practical problems involved in employer-employee relationships. It is also important that he understand the effects of various solutions of these problems on the employer, the employee, the industry, and the community outside the plant.

Although previous work experience may be offered by means of a detailed petition, it is advisable for the student to have one semester of graduate study before his work experience in order to prepare himself more adequately for his oral and written examinations. Work experience examinations must be completed at least one month in advance of the thesis examination.

Full details of the Institute program are given in the bulletin "Graduate Study in Labor and Industrial Relations" which may be obtained by writing to the Institute of Labor and Industrial Relations, 704 South Sixth Street, Champaign, Illinois.

ASSISTANTSHIPS

The Institute offers graduate assistantships to students whose undergraduate records and work experience are superior. These awards pay not less than $1,350 (plus tuition) for the academic year. The work requirement is twenty hours a week. Institute research projects, information service, and extension programs provide valuable practical experience to supplement classroom instruction. For full details see the Institute bulletin "Graduate Study in Industrial Relations." Application forms may be secured by writing directly to the Institute.

GRADUATE TEACHING FACULTY

Professors: R. W. Fleming (Director of the Institute of Labor and Industrial Relations). W. E. Chalmers, M. Derber, P. L. Garman, E. B. McNatt, W. H. McPherson, R. Stagner.

Associate Professors: Margaret K. Chandler, M. Edelman, J. B. Parrish, L. C. Pigage.

Assistant Professors: Ruth A. Hudson, S. B. Levine, H. Rosen, R. C. Wilcock, D. E. Wray.

COURSES FOR GRADUATES

418. **Seminar in Industrial Sociology.** Same as Sociology 418. Individual research in sociological interpretation of industrial organization; the orientation and motivation of the individual in industry and commerce; labor-management relations as group adjustments; the interrelations of industry and the community. I; 1 unit. Prerequisite: Six hours of sociology including Sociology 318, or consent of instructor. Wray.

420. **Formation of Public Policy.** Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legal procedures, and judicial activity. I or II; 1 unit. Hagan.

437. **Psychogenics of Industrial Conflict.** Same as Psychology 437. Offers an

opportunity for advanced study, through readings in current literature, lectures, field projects, and visiting speakers, of the psychological origins of industrial conflict. Theoretical analysis of the perceptions, emotions, motives, and frames of reference of managerial executives, workers, and union officials are supplemented by visits to industrial enterprises and union headquarters. Each student is required to do an intensive library and field study of some specific problem in labor-management relations. II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 357 or equivalent. STAGNER.

0. **Labor Economics.** Same as Economics 440. A critical economic analysis of contemporary English and American wage theory, employment and unemployment, and collective bargaining, with emphasis on public policy. I; 1 unit. Prerequisite: Six hours of economics. MCNATT.

1. **Labor Economics.** Same as Economics 441. A critical economic analysis of contemporary English and American wage theory, employment and unemployment, and collective bargaining, with emphasis on public policy. II; 1 unit. Prerequisite: Six hours of economics. MCNATT.

2. **Problems and Practices in Collective Bargaining.** Same as Economics 442. Seminar in the methods and techniques of collective bargaining in the negotiation of the labor contract; nature and significance of labor agreements; union, management, and public interests in major contract provisions. I; 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

3. **Problems and Practices of Labor Dispute Settlement.** Same as Economics 443. Seminar in the techniques of labor contract administration; comparative study of grievance procedure operation; analysis of conciliation, fact-finding, and arbitration procedures, including case studies of arbitration awards. II; 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

4. **The Labor Market.** Same as Economics 444. Basic labor force concepts and measurement; economic theory of market operation and contemporary research; long and short run changes in labor force size, composition, mobility, and participation rates; wartime problems of mobilizing labor resources; international aspects, industrial and military, of differential population and labor force growth; public policy and market operation. I; 1 unit. Prerequisite: Six hours of economics. PARRISH.

5. **The Labor Market.** Same as Economics 445. Concepts, sources of materials, methods of analysis, nature of labor supply; nature of labor demand and recruitment; determinants of interplant occupational mobility with emphasis on the wage structure and the role of wages in allocation of labor supply; adjustment to technological change; problems of the older worker; development of market policy by unions and management; development of public policy including employment service and anti-discrimination programs. II; 1 unit. Prerequisite: Six hours of economics. PARRISH.

6. **Trade Unions and the Economy.** Same as Economics 446. The economic significance of trade unionism: the role of unions as economic policy-making institutions; basic economic criteria in union-management negotiations; union policies and changing technology; unions and social security issues; effect of trade union policies and practices on the functioning of a competitive system. I; 1 unit. Prerequisite: Six hours of economics. PARRISH.

7. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure and government of the modern American trade union movement with particular reference to the relation between organization and function. Problems relating to the function and execution of economic policies, the maintenance of unity and discipline, the adjustment of jurisdictional conflicts, and the observance of agreements are examined and

appraised. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. CHALMERS, GARMAN.

448. **Problems of Personnel Administration.** Same as Management 448. An examination of the organization and administration of the personnel function in management. The course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, are carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. I; 1 unit. Prerequisite: Economics 248 or equivalent; consent of instructor.

449. **Problems of Personnel Management.** Same as Management 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students will do field work in business and industries in the area on such topics as incentives, rating, employee services, and community relations. II; 1 unit. Prerequisite: Economics 248, Labor and Industrial Relations 448, or equivalent.

450. **Case Problems in Industrial Relations.** A seminar in the analysis of case problems drawn from industry, unions, and government. The cases involve actual and specific problem situations facing industrial relations administrators. Proposed solutions are developed through both group and individual analysis, and both oral and written presentations of analyses and recommendations are used. I, II; 1 unit. Prerequisite: Labor and Industrial Relations 493 and two other graduate courses in labor and industrial relations, or consent of instructor. FLEMING, WILCOCK.

491. **Thesis Seminar.** For all students writing theses in labor and industrial relations. I, II; ½ to 2 units. STAFF.

493. **Research Seminar in Labor and Industrial Relations.** Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice and research in the field. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, LEVINE.

494. **Labor Relations in Modern Society.** An integrated analysis and summary of the principles of labor relations uniting the contributions of economics, law, political science, psychology, and sociology. I, II; 1 unit. Prerequisite: Consent of instructor. DERBER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

312. **Human Relations in Business.** Same as Management 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. I, II; ½ unit. Prerequisite: Management 101 or equivalent. HENNING.

318. **Human Relations in Industry.** Same as Sociology 318. Sociology of industry and problems of personal adjustment; the emergence of modern industrial and labor organizations and their impact upon community life. I, II; ½ unit. Prerequisite: Psychology 100, Sociology 100, or consent of instructor. CHANDLER, WRAY.

332. **History of the American Labor Movement.** Same as Economics 332. Development of the labor movement from the seventeenth century to the present; ideas and men who motivated labor and allied reform movements in socio-economic context. I or II; ½ to 1 unit.

2. **Economics of Social Security.** Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injury. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. McNatt.

3. **Collective Bargaining.** Same as Economics 343. Emergence of collective bargaining in American industry; national labor policy and bargaining; impact of bargaining on union and management structures and policies; bargaining processes and techniques; the labor agreement including contract provisions, grievance procedures, arbitration; economic consequences of bargaining; case studies of union-management relationships and problems. II; ½ to 1 unit. Prerequisite: Economics 240. Parrish.

4. **The Law and Labor.** Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; Economics 240. McNatt.

6. **Foreign Labor Movements.** Same as Economics 346. Analysis of the history, organization, economic policies, political programs, and domestic, international, and contemporary influence of the labor movements of Great Britain, Sweden, Germany, France, Latin America, and Russia. I; ½ to 1 unit. Prerequisite: Economics 240. Chalmers.

7. **Labor Law.** Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; collective bargaining and labor contracts; wages and hours legislation; unemployment compensation. II; 1 unit. Sullivan.

57. **Psychology of Industrial Conflict.** Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. Motives, emotions, attitudes, and ways of perceiving situations are considered in relation to the actions of industrial executives, factory workers, and union leaders. Results of factory observation, public opinion polls, laboratory experimentation, and psychoanalysis are integrated to provide a systematic interpretation of the problem, and to evaluate proposed actions toward a solution. I or II; ½ to 1 unit. Prerequisite: Psychology 100 or equivalent; Psychology 145, Economics 240, or Sociology 318. Rosen.

5. **Theory and Administration of Federal Labor Law.** Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor field. I or II; ½ to 1 unit. Prerequisite: Political Science 150 or 191. Edelman.

8. **Public Personnel Administration.** Same as Political Science 368. An analysis of personnel management in government. Recruitments and selection, job and salary classification, work standards, training, and the role of labor and professional organizations in the public services are considered in the light of current theory and practice. I or II; ½ unit. Prerequisite: Political Science 361 or consent of instructor. Page.

76. **Statistics of Labor.** Same as Economics 376. A study of the methods and problems involved in the derivation of "labor statistics" from both the theoretical and practical points of view. The statistical aspects of the measurement, analysis, and interpretation of data on wages, employment, labor force, and productivity are stressed. I, II; 3 hours, or ½ to 1 unit. Prerequisite: Economics 170 or equivalent.

LAW

The College of Law offers a program of graduate work leading to the degree of Master of Laws (LL.M.) and to the degree of Doctor of the Science of Law (J.S.D.).

For admission, an applicant must have received a first degree in law from the University of Illinois or from a law school approved by the University, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws degree unless he has a grade average of 3.5 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of the Science of Law is normally required to have a grade average of 4.0 in all law work previously undertaken, and also to present evidence that he has the capacity to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Bachelor of Laws degree or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for either degree. The programs consist of course work and research which have been approved by the Committee on Graduate Work of the College of Law, comprising at least eight units of graduate work, of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the LL.M. must secure an average of 3.5 in his graduate law courses; the candidate for the J.S.D., an average of 4.0.

Details of the programs may be obtained from the Dean of the College of Law.

GRADUATE TEACHING FACULTY

Professors: A. J. Harno (Dean of College of Law), K. S. Carlston, E. W. Cleary, R. G. Cohn, J. E. Cribbet, G. W. Goble, H. W. Holt, M. I. Schnebly, R. N. Sullivan, W. L. Summers, G. B. Weisiger, J. N. Young.

LIBRARY SCIENCE

The purpose of the Library School is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree and the doctor's degree in library science.

Following suitable undergraduate preparation in general educational subjects as well as professional library courses, a fifth year of advanced professional study, combined with some advanced non-library studies, leads to the degree of Master of Science in Library Science. This degree represents the minimum academic preparation for professional librarianship.

Experienced librarians of marked professional capacity and promise may pursue a program of advanced study and research leading to the degree of Doctor of Philosophy in Library Science. The normal minimum period of study is the equivalent of two years beyond the master's degree.

Students holding bachelor's degrees from any accredited institution but without previous course work in library science are eligible for admission to the master's program upon completion of a portion of the pre-graduate professional core. Normally, this may be accomplished in any regular summer session.

Students holding bachelor's degrees from any accredited four-year or five-year library school may be admitted directly to the master's program without further course work.

Degree of Master of Science. In addition to the regular requirements for admission to the Graduate College, the student must also fulfill the following minimum requirements before he will be permitted to register for advanced work in library science.

(1) A grade-point average no lower than 3.5 for that portion of undergraduate work representing the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, plus all postgraduate academic study.

(2) Successful completion of a preparatory professional program in an accredited library school, either graduate or undergraduate, or equivalent training satisfactory to the Library School; or

(3) Successful completion of a basic core of three professional courses offered by the Library School each summer session of eight weeks. A scholastic average of at least 3.75 must be made in these courses.

(4) Successful completion of a basic introductory course in each of the following subjects: sociology, psychology, education, American government, public administration, and economics. An elementary course in statistics is recommended for all graduate students and will be required of students who wish to enter the doctoral program.

If deficiencies occur, the Library School, after evaluation of the student's undergraduate program, will indicate which courses, if any, must be cleared before admission. It is possible for some deficiencies to be made up after conditional admission to the Graduate College.

(5) A reading knowledge of one modern foreign language. Students specializing in bibliographical work and in college or university library administration must have a reading knowledge of at least two foreign languages and statistics.

(6) Evidence of ability to pursue graduate work in library science.

All students whose undergraduate professional training was completed at institutions other than the University of Illinois will be given, at the beginning of the semester in which they enter, a placement examination in the basic principles and techniques of librarianship. The results of this examination will be used in determining the student's program of study.

Correspondence regarding admission should be addressed to the Associate Director of the Library School from whom the detailed Library School announcement and the necessary application blanks can be secured. All applications, transcripts, and other necessary papers should be filed as early as possible, and not later than four weeks before the date of registration. No student should complete his plans for attending the Library School until he has been notified of his admission.

No thesis is required but each student will designate one of his regular course papers as his master project. The subject of this paper will be determined by the student and approved by the instructor of the course in which it is to be written. The title of the paper is to be filed in the Library School office not later than two weeks after the start of the semester in which the student expects to graduate. Two typewritten copies of this report are to be prepared, one for the instructor of the course and the other to be deposited in the Office of the Associate Director of the Library School not later than two weeks before the date on which the degree is to be conferred.

At least two semesters in residence or the equivalent, and the completion of nine units of graduate work are required. Each student's program of study will be developed for his particular needs and purpose. At the time of registration each student will be assigned an adviser from the Library School faculty. Gov-

erned by his previous training, the student will be encouraged to take a portion of his course work outside the Library School.

Degree of Doctor of Philosophy. A student desiring to pursue a program of study and research leading to the degree of Doctor of Philosophy in Library Science must meet the customary admission requirements of the Graduate College. In addition, he must meet the following requirements of the Library School:

(1) A master's degree in library science from an accredited library school or an equivalent acceptable to the Library School.

(2) A substantial period of acceptable professional library experience.

The normal minimum period of study required for the degree of Doctor of Philosophy is two years beyond the master's degree, during which the student is required to devote all his working time to studies. All three years must be spent in resident graduate study at some accredited educational institution, and either the first two or the last one of the three must be spent at the Universiy of Illinois. The degree is conferred, however, not for residence during a certain period, but for scholarly attainments and power of investigation, as proved by a thesis and examinations.

Candidates for this degree must meet the general requirements of the Graduate College regarding residence, language requirements, academic program, and thesis.

FELLOWSHIPS AND ASSISTANTSHIPS

The Katharine L. Sharp Fellowship was endowed in 1933 by the Illinois Library School Alumni Association as a memorial to the founder of the School. It is awarded on recommendation of the faculty. The stipend is $600 and exemption from tuition.

Several assistantships in the University Library and in the Library School are open each year to properly qualified candidates. Graduate students in the Library School who have completed the bachelor's degree with eighteen hours of library science or its equivalent are eligible for part-time academic appointments to the Library staff. Appointments are made for one year and may be renewed once. Half-time appointments require twenty hours of work each week at duties assigned by the Director of the Library and Library School; three-quarter time appointments require thirty hours. The minimum stipend for a half-time assistantship is $1,350 for the academic year; for a three-quarter time appointment, $2,025. Such appointments include exemption from tuition and fees.

GRADUATE TEACHING FACULTY

Professors: R. B. Downs (Director of Library School), L. W. Dunlap, A. H. Lancour, Rose B. Phelps.

Associate Professors: L. E. Bamber, Thelma Eaton, Frances B. Jenkins, C. W. Stone (on leave first semester 1954-1955), D. E. Strout.

Assistant Professors: Alice N. Fedder, Marie M. Hostetter, W. V. Jackson, M. Alice Lohrer.

Instructors: Viola James, B. M. Woods.

COURSES FOR GRADUATES

401. **Communications.** An introduction to the mass media of communications, i.e., print, broadcasting, and films, as they affect modern society. Problems, studies, and the principal techniques of research in communications are considered from the viewpoint of librarians. I; 1 unit. Prerequisite: Completion of undergraduate library core, or equivalent. Stone.

402. **Studies in Reading.** Designed to acquaint students with the major areas of

investigation and library interest in reading. Special attention is given to studies of reading interests and habits. II; 1 unit. Prerequisite: Library Science 401. STONE.

3. **Methods of Investigation.** Survey of library literature, with attention to examples of research in the library field, to elementary statistical procedures, and to the methods of investigation applicable to librarianship. Designed to prepare consumers rather than producers of research results, and to help students in their work on master's papers. I; 1 unit. JENKINS.

4. **Reading of Young People.** Concerned primarily with the major areas of investigation in the field of reading for young people. Class discussions are devoted to analysis of various studies and their implications for librarians working with children and young people. II; 1 unit. Prerequisite: Library Science 401. LOHRER.

5. **Library Administration.** Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. I, 1 unit. Prerequisite: Completion of undergraduate library core, or equivalent. JENKINS.

6. **Library Service to Children and Young People.** The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young people in the public library. II; 1 unit. Prerequisite: Completion of undergraduate library core, or equivalent. FEDDER, HOSTETTER, JAMES, LOHRER.

7. **Cataloging and Classification, I.** The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Dewey Decimal and Library of Congress classification schemes and the Library of Congress Subject Headings. I; 1 unit. Prerequisite: Completion of undergraduate library core, or equivalent. EATON.

8. **Cataloging and Classification, II.** The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloging department. II; 1 unit. Prerequisite: Library Science 407. EATON.

10. **Teaching Function of the Library.** Considers the implications of regarding libraries as educational institutions, and the contribution of this concept to a philosophy of librarianship. Study is made of outstanding applications in the profession. II; 1 unit. STONE.

11. **Bibliography of the Humanities and Social Sciences.** Detailed consideration of the bibliographical and reference materials in some ten subject fields, with training and practice in their use for solving questions arising in reference service. I; 1 unit. Prerequisite: Completion of undergraduate library core, or equivalent. PHELPS.

12. **Bibliography of Science and Technology.** Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. II; 1 unit. Prerequisite: Completion of undergraduate library core, or equivalent. JENKINS.

24. **Government Publications.** The nature and scope of American and British government publications; and the problems of organization arising from

their form and from the methods of their production and distribution. II; 1 unit. PHELPS.

427. **Resources of American Libraries.** Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; types of library materials; and ways and means of developing research collections in special subject fields. I; 1 unit. JACKSON.

428. **Physical Problems of Libraries.** Consideration of principles and problems affecting the construction, remodeling, and equipment of the main types of libraries, with emphasis on their interrelationships, administrative implications, and recent developments. II; 1 unit. STROUT.

430. **Advanced Bibliography.** Designed to enable the student to utilize the varied resources of a large research library. Deals with the methods of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. II; 1 unit. Prerequisite: Library Science 424 or consent of instructor. PHELPS.

432. **History of Books and Printing.** The origin and evolution of the alphabet and of scripts; the history of manuscript books; the invention and spread of printing; the account of the production and distribution of printed books. Emphasis is placed on the relation of books to social conditions in the various periods studied. II; 1 unit. EATON.

433. **Biological Literature and Reference Work.** Introduction to use of the indexes and abstract journals serving the biological sciences and related fields. The handling of pertinent general library aids, the preparation of scientific manuscripts, and the history of scientific societies also are considered. I, II; ¼ unit. Prerequisite: Consent of instructor. BAMBER.

434. **Larger Units of Library Organization.** A study of cooperation, contracts, county and regional arrangements, and other devices for the provision of school and public library service by units covering more than a local area. Emphasis is on legal and administrative aspects, and not on operational procedures. II; 1 unit. STROUT.

436. **Development of the Library Catalog.** The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. II; 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor. EATON.

439. **Medical Literature and Reference Work.** Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources. I; 1 unit. Prerequisite: Consent of instructor. JENKINS.

451. **Problems in Reference Service.** Examines the assumptions on which the interpretation of library resources is based, to consider the objectives of such service and the policies which lead to their attainment. I; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. PHELPS.

452. **Education for Librarianship.** A study of the development of library education in this country and abroad. Not a course in teaching methods, but designed to provide understanding of the philosophical foundations of the several training agencies through analysis of their methods, content, character of personnel, and relationship to the profession at various times. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. LANCOUR.

53. **Problems in Cataloging and Classification.** Analysis of the major technical and organizational problems of cataloging and classification, accompanied by a critical survey of the studies made in this area. I; 1 unit. Prerequisite: Courses comparable to Library Science 407 and 408, or consent of instructor. EATON.

54. **College and University Library Problems.** Investigation and review of administrative and educational problems in college and university libraries. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. DUNLAP.

55. **Problems of Research in Reading.** Intensive analysis of selected research problems related to reading. Provides opportunity for independent investigation, and for critical review of the major assumptions, methods, and conclusions of work done in particular fields; and considers implications for the policy and practice of libraries. I; 1 unit. Prerequisite: Master of Science in Library Science and Library Science 402 or 404, or consent of instructor. STONE.

56. **Public Library Problems.** Study of the major questions in the administration and organization of public libraries. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STONE.

57. **Librarianship and Society.** Emphasis in this course is on the place of libraries today as social institutions and in relation to social trends. Consideration is given to the role of the librarian as an individual and as a professional worker in contemporary society. I; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STROUT.

58. **School Library Problems.** Examination of current practices and major problems of the school library field. Provides opportunity for independent investigation of selected problems. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. HOSTETTER.

59. **Principles of Research Methods.** Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. I; 1 unit. Prerequisite: Knowledge of the principles of statistics; Master of Science in Library Science or consent of instructor. STONE.

91. **Thesis.** Individual study and research for doctoral candidates. I, II; 1 to 4 units. DOWNS, EATON, LANCOUR, PHELPS, STONE.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

01. **Literature of the Humanities and Social Sciences.** The purpose is to increase knowledge of the scope and significant characteristics of the literature in the social sciences and the humanities by systematic study of modern trends, themes, and representative materials. Provides an introduction to each field, and emphasizes development of skills in selection as related to library problems and processes. I; 1 unit. STROUT.

02. **Literature of Science and Technology.** A survey of the fields of pure and applied science and a study of the literature of each. Designed to give understanding of the content of the scientific disciplines and of their role in modern society. Selected readings acquaint students with the characteristics of the literature. II; 1 unit. JENKINS.

03. **Library Materials for Children.** The selection and use of library materials for children in public and school libraries, according to the needs of the

child in his physical, mental, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard book selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. I, II; 1 unit. HOSTETTER, LOHRER.

304. **Library Materials for Adolescents.** The selection and use of library materials for adolescents in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. I, II; 1 unit. HOSTETTER, LOHRER.

306. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the cataloging, classification, and care of maps. Classes become familiar with the major cartobibliographical and related tools. II; ½ unit. WOODS.

308. **Audio-Visual Services in Libraries.** Considers the development of audio-visual work in libraries. Students are made aware of the range, types, and functions of the audio-visual materials, equipment, and services commonly provided, and of some of the organizational and technical problems met by specialists in the field. Laboratory sessions furnish conversance with projection, recording, and comparable processes. II; ½ unit (or 1 unit for candidates for the master's degree in the Library School, upon approval). STONE.

MANAGEMENT

The Department of Management offers graduate work either as a major or a minor leading to the degree of Master of Science, and as a minor for the Doctor of Philosophy degree.

For admission a student must have a grade-point average of 3.5 or above for that portion of the work which represents the last fifty per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training.

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration subjects such as accountancy, business law, economics, management, and marketing, at least six hours of which must have been in the field of management. To do minor work in this field, a student must have had at least twelve hours of work in the subjects named above, of which three must have been in management.

FELLOWSHIPS AND ASSISTANTSHIPS

Graduate students in management may apply for University Fellowships which are awarded by the Graduate College. Applications must be filed with the Dean of the Graduate College before February 15 of the academic year preceding that for which the fellowship is desired.

Teaching assistantships are usually available for highly recommended candidates for any of the graduate degrees sponsored by the Department. For information write the Head of the Department.

GRADUATE TEACHING FACULTY

Professors: M. J. MANDEVILLE (Head of Department), A. G. ANDERSON, L. A. BRYAN, R. DUBIN, P. M. GREEN.

URSES FOR GRADUATES

1. **Scientific Management.** A study of the development of modern industrial management and the principles and practices employed at the present time. I; 1 unit. ANDERSON.

2. **Scientific Management.** A study of the development of modern industrial management and the principles and practices employed at the present time. II; 1 unit. ANDERSON.

3. **Evolution and Development of Industry.** The evolution of industry from ancient times to the present. The social, economic, and political developments consequent upon the change from manufacturing for personal use to the present-day mass production industries. Consideration is given to the transition in organization for manufacture, technological changes, capital requirements, human relations, production processes, the location of industries, governmental control, and management responsibilities. I, II; 1 unit. ANDERSON.

5. **Problems in Business Policy.** Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. I, II; 1 unit. MANDEVILLE.

3. **Problems of Personnel Management.** Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. The course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, are carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. I; 1 unit. Prerequisite: Economics 248 or equivalent; consent of instructor. DUBIN.

). **Problems of Personnel Management.** Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students will do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. II; 1 unit. Prerequisite: Economics 248, Management 448, or equivalent. DUBIN.

. **Thesis.** I, II; 1 unit. ANDERSON, GREEN, MANDEVILLE.

JRSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

. **Management in Manufacturing.** Internal problems of production and efficient control in factories. I, II; ½ unit. Prerequisite: Management 101.

. **Administrative Policies and Organization.** Development of administrative organizations and the determination of policies for the integration of major activities of a business enterprise. I, II; ½ unit. Prerequisite: Management 101; Marketing 101. MANDEVILLE.

. **Human Relations in Business.** Same as Labor and Industrial Relations 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. I, II; ½ unit. Prerequisite: Management 101 or equivalent.

. **Job, Wage, and Contract Administration.** An advanced, specialized treatment of the techniques, methods, and problems current in the wage and salary field. I, II; ½ unit. Prerequisite: Any one of the following courses or their equivalent: Psychology 145, 290, Economics 240, 248.

MARKETING

Work may be done in the field of marketing for a major or a minor for the Master of Science degree, and for a minor for the Doctor of Philosophy degree. To do major work in this field, a student must meet the general requirements for admission with full standing as described on page 13 and must have completed at least twenty hours of undergraduate work in marketing, management, economics, business law, or accountancy, at least six hours of which must have been in the field of marketing. To do minor work in this field a student must have had at least twelve hours of work in the subjects named above, of which three must have been in marketing.

GRADUATE TEACHING FACULTY

Professors: P. D. Converse (Head of Department), F. H. Beach, H. W. Huegy, F. M. Jones, H. G. Wales.
Associate Professor: N. Wedding.
Assistant Professors: R. H. Cole, R. D. Millican, Robert Mitchell.
Instructors: L. M. DeBoer, R. S. Hancock.

COURSES FOR GRADUATES

401. **Marketing Principles and Problems.** Functional, commodity, and institutional methods of studying marketing with particular reference to the analysis and classifications of functions, commodities, and institutions. I; 1 unit. Converse.

402. **Marketing Methods and Problems.** Selected problems in the operation and management of market institutions. II; 1 unit. Converse.

407. **Prices and Price Policies.** An examination of the role of prices in our economy, and of price making under conditions of competition, monopoly, or monopolistic competition, with special emphasis on non-price competition; an examination of business pricing policies and of their acquisitive and social implications and significance. I, II; 1 unit. Huegy.

415. **Merchandising Trends and Problems.** The literature, trends, policies, and organization problems involved in retail merchandising. I; 1 unit. Jones.

416. **Merchandising Policies and Problems.** The policies and problems relating to merchandise control, personnel, publicity, and promotion; recent literature and legislation. II; 1 unit. Jones.

421. **Analysis of Consumer Markets.** A study of consumers and their demands. I, II; 1 unit.

471. **History of Marketing.** The development of marketing organizations, problems, and methods in the United States from colonial times to the present. Wholesaling, retailing, market growth, consumer buying habits, advertising, selling, pricing, legislation, trade channels. II; 1 unit. Jones.

472. **Sales Campaigns.** Problems in managing the sales force. II; 1 unit. Beach.

481. **Advanced Advertising Principles.** Same as Journalism 481 and Mass Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. Sandage.

482. **Research Methods in Advertising and Communications.** Same as Journalism 482 and Mass Communications 482. Concepts and procedures in the social sciences with emphasis on advertising and communication. Both nonquantitive and quantitive methods are examined. I; 1 unit. Sandage.

491. **Thesis.** Thesis or independent study in the field of marketing. I, II; 0 to 2 units. Converse, Huegy, Jones, and others.

3. **Research in Special Fields.** I, II; ¼ to 2 units.

URSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

5. **Contemporary Problems in Marketing Management.** The problems which marketing managers are currently facing and an analysis of the policy decisions they must make to operate effectively. I, II; ½ unit. Prerequisite: Marketing 101. CONVERSE, MITCHELL, HUEGY.

5. **Retail Buying.** Principles and procedures in buying for resale. Organization for buying, analysis of customer demand, model stock plans, sources of supply, resident buying, cooperative and central buying, foreign buying, selection of merchandise, and trade relations. I, II; ½ unit. Prerequisite: Marketing 211. HANCOCK.

1. **Marketing Research and Policies.** The basic techniques used in business research and specific research projects, and how their findings are used in the formulation of marketing policies. I, II; ½ unit. Prerequisite: Marketing 101.

3. **Problems in Business Research.** Selected problems in the field of commercial research. I, II; ½ to 1 unit. Prerequisite: Marketing 321.

5. **Sales Distribution and Cost Analysis.** Basic techniques and principles of sales and distribution cost analysis for management control of marketing activities. I, II; ½ unit. Prerequisite: Marketing 101; senior standing or consent of instructor. MITCHELL.

1. **Grain Grading and Marketing.** Same as Agricultural Economics 331 and Agronomy 331. Factors affecting the quality of grain crops; standards employed in their classification and grading on the commercial market; laboratory practice in grain grading; a trip to a commercial grain grading laboratory; economic problems and market operations in grain marketing. I; ½ unit. Prerequisite: Agricultural Economics 230 and Agronomy 121, or consent of instructor. NORTON, WEIBEL.

2. **Livestock Marketing.** Same as Agricultural Economics 332 and Animal Science 332. Problems and practices in marketing livestock. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. KIRTLEY, NORTON.

3. **Marketing Horticultural Products.** Same as Agricultural Economics 333 and Horticulture 333. Producing and consuming areas; transportation; refrigeration; agencies, functions, and channels of distribution; cooperatives; marketing costs and factors affecting prices; standardization, grading, and inspection; marketing news service; perishable agricultural commodity act and other regulations; attempts to control surpluses; canning and other processing; foreign trade; consumer preference and expansion of domestic markets. I; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or five hours of horticulture or consent of instructor. KELLY.

4. **Marketing Dairy Products.** Same as Agricultural Economics 334 and Dairy Science 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

5. **Credits and Collections.** Retail and mercantile credit and collection principles and practices. I, II; ½ unit. Prerequisite: Marketing 101. COLE.

6. **Trade Associations and Commercial Organizations.** Principles of trade asso-

ciation and chamber of commerce organization and management. II; ½ unit Prerequisite: Marketing 101. HANCOCK.

372. **Advanced Salesmanship.** An application of sales techniques to actual selling situations. Students make sales presentations, and critical appraisals are given. I, II; ¼ unit. Prerequisite: Marketing 271. WALES.

373. **Sales Management.** Modern sales organization; selling problems of manufacturers, wholesalers, and retailers; management of salesmen. I, II; ½ unit Prerequisite: Marketing 271. BEACH.

382. **Advertising Copy and Layout.** Same as Journalism 382. Theory and practice of advertising copy writing and layout for newspaper, magazine, and direct mail; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. I, II; 1 unit. Prerequisite: Journalism 204 and 281. SARGENT.

383. **Advertising Media.** Same as Journalism 383. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. I, II; ½ unit. Prerequisite: Marketing 281.

384. **Advertising Campaigns.** Same as Journalism 384. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements — copy and layout. I, II; ½ unit. Graduate students will not receive credit for both Marketing 384 and 387. Prerequisite: Marketing 282 or 382; and 383. WEDDING.

385. **Advertising Promotion and Sales.** Same as Journalism 385. Sales problems advertising promotion, advertising research, market research. I, II; ½ unit Prerequisite: Marketing 281. MCCLURE.

386. **Radio and Television Advertising.** Same as Journalism 386. Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. I, II; ½ unit Prerequisite: Marketing 281. SANDAGE.

387. **Advertising Policies and Problems.** Same as Journalism 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Consideration given to management problems at both the national and retail levels. I, II; ½ to 1 unit. Graduate students will not receive credit for both Marketing 384 and 387. Prerequisite: Marketing 281. WEDDING.

MASS COMMUNICATIONS

The Institute of Communications Research is an interdepartmental group engaged in the study of problems relating to the communication process and its use in society. Membership includes an advisory group of fellows representing the social science and media departments, a senior staff appointed part time in the Institute and part time in related departments, and a number of research associates and assistants. The Institute has IBM equipment and maintains a varied research program including a number of defense contracts. Each year a limited number of graduate students are admitted to an interdepartmental program of study leading to the degree of Doctor of Philosophy in Mass Communications.

The program is designed to apply the methods and disciplines of the social sciences (supported where necessary by the arts and natural sciences) to the basic

problems of human communication and is intended for students whose academic and professional experience qualifies them to study mass communications, and whose plans for careers are such as to make this interdepartmental degree more desirable than a degree in one of the social sciences. Among such careers may be the teaching of journalism, radio, or other communication subjects, research in the fields of public opinion or audience study, and executive jobs in the communication industries requiring breadth, perspective, and a scientific background.

Prerequisites to admission to this program are at least one course in each of the following subjects: psychology, sociology, political science, economics, and statistics. If a student lacks one of these prerequisites, he may be admitted probationally while he makes up the deficiency, but he may not count that course among the twenty-four units required for the degree.

A candidate for this degree is expected to meet the following requirements:

(1) A total of twenty-four units of graduate work, among them

(a) Four or more units of graduate courses in mass communications, such as 390, 391, 421, 426, 444, 462, 471, 473, 474, 481 below.

(b) One or more units in research methods or field studies, such as 366, 367, 370, 455, 482, below.

(c) Two minors in social sciences or, in special cases, in other areas approved by the administrative committee. A minor is here defined as three or more graduate units.

(d) Electives as needed to make twenty-four units and as approved by the administrative committee. These electives are often used to broaden the background in social science, to strengthen the minors, or, especially in the case of a candidate preparing for experimental work, to add more work in statistics and higher mathematics.

(2) Reading knowledge of two modern foreign languages, preferably French, German, or Russian.

(3) A written examination covering the broad field of communication. The candidate is eligible to take this examination when he has earned sixteen units and has passed his foreign language examinations.

(4) A satisfactory dissertation on some topic in mass communications.

(5) A final examination centered on, but not restricted to, the field of the dissertation.

A candidate for the degree of Doctor of Philosophy who wishes to minor in mass communications should select four, three, or two courses (according to the requirements of his major department) from the following list. Such a candidate is expected to have a social science background sufficient for such courses as he chooses. If he has any doubt as to the adequacy of his background, he should consult the chairman of the administrative committee who will also advise him as to desirable combinations and sequences of courses.

Inquiries for further information should be addressed to F. S. Siebert, 119 Gregory Hall, Urbana.

ASSISTANTSHIPS

A number of research assistantships are available in the Institute of Communications Research. For details, inquire of Professor Wilbur Schramm, 120 Gregory Hall, Urbana. For teaching assistantships available in journalism, inquire of Professor F. S. Siebert, 119 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: F. S. Siebert (Chairman of Administrative Committee), J. W. Albig, C. B. Hagan, C. E. Osgood, C. H. Sandage, W. Schramm, D. W. Smythe.

COURSES FOR GRADUATES

421. **Government and the Economic Order.** Same as Political Science 421. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. I or II; 1 unit. HAGAN.

426. **Experimental Psychology of the Communication Process.** Same as Psychology 426. A critical survey of methods and theories in the psychological study of the communication process, with the emphasis upon the development of symbolic behavior, experimental semantics, and frequency studies; application will be made to various problems in social science. II; 1 unit. Prerequisite: Six units of graduate credit in psychology or consent of instructor. OSGOOD.

444. **Seminar in Public Opinion.** Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. I, II; 1 unit. ALBIG.

446. **Opinion Polling Analysis.** Same as Sociology 446. The study of current polling practices, organizations, and findings; evaluation of results in terms of the prediction and interpretation of social behavior. I, II; 1 unit.

455. **Psychology of Opinion and Attitude.** Same as Psychology 455. Theory and practice in measurement of opinion and attitude formation and change. Attitude scales; factors affecting morale; interpretation of results from social and psychological characteristics of the population; intensity of attitudes; relations among attitudes and opinions. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 451, or consent of instructor. THISTLETHWAITE.

462. **Seminar in Radio and Television.** Same as Journalism 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. II; 1 unit. SKORNIA.

471. **Theory of Communications.** Same as Journalism 471. Nature of the communication process; development of communication patterns and institutions; principles governing the control and support of mass communications; content and audience study; effects of communication; and relation of mass communications to public opinion and group action. I; 1 unit. SCHRAMM.

473. **History and Theory of Freedom of the Press.** Same as Journalism 473. Development of the Anglo-American press system; philosophical bases of competing press systems. I; 1 unit. SIEBERT.

474. **Government and Mass Communications.** Same as Journalism 474. Current legal, constitutional, and administrative problems of media of mass communications; contemporary issues resulting from the restrictive, regulatory, and supplementary activities of government in the field of mass communications. II; 1 unit. SIEBERT.

481. **Advanced Advertising Principles.** Same as Journalism 481 and Marketing 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Journalism 482 and Marketing 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both non-quantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

490. **Research in Special Topics.** Same as Journalism 490. I, II; ½ to 1 unit.

Students may re-register for a total of 2 units. Prerequisite: Consent of instructor. STAFF.

492. **Thesis.** I, II; 1 to 4 units each semester. Prerequisite: Consent of chairman and thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

366. **Theory of Sample Survey.** Same as Mathematics 366. The development of the formulae to be used in the efficient planning of sample surveys and the interpretation of the results. I, II; 1 unit. Prerequisite: Differential and integral calculus and a first course in statistics. MADOW.

367. **Practice of Sample Surveys.** Same as Mathematics 367. Training in planning and making sample surveys; how the results are interpreted. One or more sample surveys are planned in detail. I, II; 1 unit. Prerequisite: Differential and integral calculus and a first course in statistics. MADOW.

370. **Applied Statistical Analysis.** Same as Economics 370. A general course in statistical methods applied to the subject matter fields of the College of Commerce and Business Administration; intended principally for those students who have entered or intend to enter a program of graduate study and whose training in the basic statistical methods employed in these disciplines is inadequate. I; 1 unit. Prerequisite: Admission to candidacy for a graduate degree with no more than one course in economic statistics; or, in case of undergraduates, thirty hours of commerce subjects. Credit is allowed for this course in addition to that for Economics 271. NEISWANGER.

390. **Economics of Communications, I.** Same as Economics 390 and Journalism 390. Economic problems associated with the various forms of radio broadcasting including FM, television, and facsimile, and the use of radio for the safety and efficiency of transportation, protective services, etc. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

391. **Economics of Communications, II.** Same as Economics 391 and Journalism 391. Economic problems associated with the following means of communications: motion pictures, newspapers, magazines, and books. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the degrees of Master of Arts or Master of Science and Doctor of Philosophy in Mathematics and in Statistics. Research for the doctor's degree in mathematics can be carried out in the fields of algebra, analysis, applied mathematics, geometry, and topology.

MATHEMATICS

For admission to full standing, a beginning graduate student must have a grade-point average of not less than 3.5 for that portion of his undergraduate work representing the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students will be admitted on limited status.

Students beginning graduate study with a major in mathematics must have had twenty hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and one year of more advanced work in one or more of the fields of algebra, analysis, and geometry.

Candidates for a Doctor of Philosophy degree taking a sole minor in mathematics are expected to complete four units approved by the department. Those taking a first or second minor are required to complete at least two units beyond the calculus.

The more technical courses offered by the department are arranged mainly in cycles of two or of three years, so that a properly qualified student will usually have opportunity to take any particular course at some time during the three years of residence required for the doctor's degree.

Candidates for the degree of Master of Science in the Teaching of Mathematics must earn four units in mathematics (two units of which are electives), two units in education, and two units in electives. Requirements are Mathematics 317 or 327, one unit; Mathematics 318 or 328, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in mathematics and the other electives must be selected with the approval of the adviser. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have the same grade-point average as that required by the department. Students on limited status will not be admitted to this program. The adviser for candidates for this degree is Professor H. R. Brahana, 357 Mathematics Building.

Candidates for the degree of Master of Science in the Teaching of Mathematics and the Physical Sciences must earn two units in mathematics, one unit in chemistry, one unit in physics, two units in education, and two units in electives. Requirements are Mathematics 347 or 343, one unit; Mathematics 348 or 345, one unit; Chemistry 240, one unit; Physics 322, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives may be in mathematics, in education, in chemistry, or in physics. Students applying for admission must have a grade-point average of at least 3.5 for that portion of work which represents the last fifty per cent of the hours earned for the bachelor's degree, exclusive of required courses in physical education and military training. Students on limited status will not be admitted. The adviser for candidates for this degree is Professor H. R. Brahana, 357 Mathematics Building.

ASSISTANTSHIPS IN MATHEMATICS

Graduate assistantships are available for a limited number of highly qualified degree candidates. The department does not approve teaching loads in excess of half time for assistants. Inquiries and requests for application forms should be addressed to the Department of Mathematics.

STATISTICS

The program of graduate work leading to the degrees of Master of Arts and Doctor of Philosophy in Statistics is administered by the Department of Mathematics with the help of a small interdepartmental committee. The thesis for the degree of Doctor of Philosophy must show capacity for important original contributions to one or more of the following: the develpment of new statistical ideas and methods, research improving the applications of statistical methods, and new applications of statistical methods in some field of application. The thesis requirement for the degree of Master of Arts is frequently waived.

For admission to full standing a beginning graduate student must have a grade-point average of not less than 3.5 for that portion of his undergraduate work representing the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. In addition, the student must have had a thorough course in the calculus. While not

specifically required for admission, a course in advanced calculus will usually be found helpful. Students will be admitted on limited status.

Candidates for the degree of Doctor of Philosophy in Statistics must satisfy the following course requirements:

(1) *Mathematics.* Mathematics 315, 347, 348, or similar courses of approximately equivalent content.

(2) *Theoretical Statistics.* Mathematics 363 and eight additional units of which at least four are 400 numbered courses, from a list of courses prepared by the Department of Mathematics, and including all courses jointly listed by the Department of Mathematics and areas of application of statistics.

(3) *Area of Application.* Four units, of which at least two must be 400 numbered courses, and none of which may emphasize training in statistical methods as such. These courses must be taken in some single field of application of statistical methods.

(4) *Optional.* At least six units, of which at least four are 400 numbered courses. These courses may not be taken in more than two departments.

Candidates for the degree of Master of Arts in Statistics must satisfy the following course requirements: Mathematics 315, 347, 348, 363, or their equivalents, one other unit of 300 numbered courses and two units of 400 numbered courses in theoretical statistics, two units of courses under (3) and two units of courses under (4), above.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 18-24) he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

The courses required under (4) above are determined by the interests of the student. They may be taken in general statistics, in mathematics, or in an area of application. Thus, the graduate degrees in statistics permit considerable variation in the division of emphasis between general statistics and the area of application. A graduate student in statistics will have two advisers, one for statistical theory, one for the area of application.

Candidates for a Doctor of Philosophy degree taking a first minor in statistics are expected to have completed a course in the calculus and are required to complete four units of work in statistics having the calculus as prerequisite. Those taking a second minor in statistics are required to complete at least two units of work in statistics having the calculus as prerequisite.

A mimeographed statement giving additional details concerning the program may be secured by writing to the Statistical Research Laboratory, Department of Mathematics.

ASSISTANTSHIPS IN STATISTICS

Graduate assistantships, for not more than half time, are available for a limited number of highly qualified degree candidates. Inquiries and requests for application forms should be addressed to the Statistical Research Laboratory, Department of Mathematics.

The following members of the Department of Mathematics give courses intended primarily for graduate students in statistics: Professors W. G. Madow, Chairman, Statistical Research Laboratory, C. R. Blyth, K. A. Bush, and J. L. Doob.

GRADUATE TEACHING FACULTY

Professors: S. S. Cairns (Head of Department), R. Baer, D. G. Bourgin, H. R. Brahana, M. M. Day, J. L. Doob, G. P. Hochschild, P. W. Ketchum, H. Levy, W. G. Madow, H. J. Miles, A. H. Taub, W. J. Trjitzinsky.

Associate Professors: P. Bateman, F. E. Hohn, C. W. Mendel, M. E. Munroe, J. W. Peters, R. E. Pingry, L. L. Steimley, H. E. Vaughan, W. Wilson.

Assistant Professors: Beulah M. Armstrong, W. F. Atchison, C. R. Blyth, O. K. Bower, K. A. Bush, Josephine H. Chanler, W. A. Ferguson, N. S. Hawley, Jr., A. Heller, V. A. Hoersch, J. Landin, R. G. Langebartel, B. E. Meserve, Echo D. Pepper, I. Reiner, L. Schoenfeld, E. J. Scott.

Instructors: Corinne R. Hattan, Jewell E. Schubert.

COURSES FOR GRADUATES

401. **Theory of Fields.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.
402. **Linear Algebra.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.
403. **Theory of Rings.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.
404. **Group Theory.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.
405. **Commutative Ideal Theory and Valuations.** I, II; 1 unit. Prerequisite: Two graduate courses in algebra, including Mathematics 401.
406. **Algebraic Number Theory.** I, II; 1 unit. Prerequisite: Mathematics 353, 354, and 405.
407. **Representation Theory and Classical Groups.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.
408. **Lie Groups.** I, II; 1 unit. Prerequisite: Mathematics 332, 404, and 441.
415. **Advanced Topics in the Theory of Groups.** I, II; 1 unit. Prerequisite: Consent of instructor.
416. **Advanced Topics in Abstract Algebra.** I, II; 1 unit. Prerequisite: Consent of instructor.
419. **Seminar in Algebra.** I, II; 1 unit. Prerequisite: Consent of instructor.
420. **Projective Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328.
421. **Line Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328 and either Mathematics 420 or consent of instructor.
422. **Algebraic Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328.
423. **Differential Geometry.** I, II; 1 unit. Prerequisite: Mathematics 343.
424. **Riemannian Geometry.** I, II; 1 unit. Prerequisite: Mathematics 420, or 423, or consent of instructor.
425. **Riemannian Geometry.** I, II; 1 unit. Prerequisite: Mathematics 424.
426. **Differential Geometry in the Large.** I, II; 1 unit. Prerequisite: Mathematics 332 or 423, or consent of instructor.
427. **Foundations of Geometry.** I, II; 1 unit. Prerequisite: Consent of instructor.
428. **Topics in Geometry.** I, II; 1 unit. Prerequisite: Consent of instructor.
429. **Seminar in Geometry.** I, II; 1 unit. Prerequisite: Consent of instructor.
432. **Separable Metric Spaces.** I, II; 1 unit. Prerequisite: Mathematics 332.
433. **Locally Connected Spaces.** I, II; 1 unit. Prerequisite: Mathematics 332.
434. **Combinatorial Theory of Polyhedra.** I, II; 1 unit. Prerequisite: Mathematics 333.
435. **Combinatorial Theory of Spaces.** I, II; 1 unit. Prerequisite: Mathematics 332 and 434.

438. **Topics in Topology.** I, II; 1 unit. Prerequisite: Consent of instructor.

439. **Seminar in Topology.** I, II; 1 unit. Prerequisite: Consent of instructor.

440. **Theory of Functions of a Complex Variable, I.** I, II; 1 unit. Prerequisite: Mathematics 348 and 349, or consent of instructor.

441. **Functions of Real Variables.** I, II; 1 unit. Prerequisite: Mathematics 347.

442. **Measure and Integration.** I, II; 1 unit. Prerequisite: Mathematics 347; consent of instructor.

443. **Ordinary Differential Equations.** I, II; 1 unit. Prerequisite: One year of graduate analysis; consent of instructor.

444. **Partial Differential Equations.** I, II; 1 unit. Prerequisite: Consent of instructor.

445. **Theory of Functions of a Complex Variable.** I, II; 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. **Hilbert Space.** I, II; 1 unit. Prerequisite: Mathematics 442.

447. **Banach Spaces.** I, II; 1 unit. Prerequisite: Mathematics 442.

448. **Locally Compact Groups and Their Representations.** I, II; 1 unit. Prerequisite: Mathematics 442.

449. **Normed Rings.** I, II; 1 unit. Prerequisite: Mathematics 318 and 446, 447, or 448.

450. **Semi-Ordered Spaces.** I, II; 1 unit. Prerequisite: Mathematics 446, 447, or 448.

451. **Theory of Probability.** I, II; 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** I, II; 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 348 and 353, or 317.

454. **Analytic Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods in Physics.** I, II; 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods in Physics.** I, II; 1 unit. Prerequisite: Mathematics 455.

457. **High-Speed Computing.** I, II; 1 unit. Prerequisite: Consent of instructor.

458. **Hydrodynamics.** I, II; 1 unit. Prerequisite: Mathematics 348.

459. **Topics in Hydrodynamics.** I, II; 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy 424 and Physics 424. I; 1 unit. Prerequisite: Consent of instructor.

461. **Special Relativity.** I, II; 1 unit. Prerequisite: Consent of instructor.

462. **Propagation.** I, II; 1 unit. Prerequisite: Consent of instructor.

468. **Topics in Analysis.** I, II; 1 unit. Prerequisite: Consent of instructor.

469. **Seminar in Analysis.** I, II; 1 unit. Prerequisite: Consent of instructor.

470. **Statistical Decision Functions.** Statistics from the point of view of decision making; introduction to the theory of games; minimax and other decision functions; techniques for determining optional decision functions; applications to non-sequential and sequential decision making in practice. I, II; 1 unit. Prerequisite: Consent of instructor.

472. **Econometrics.** Same as Economics 472. Application of the principles of mathematical statistics to estimation of economic relationships. II; 1 unit. Prerequisite: Mathematics 363; consent of instructor.

473. **The Theory of Testing Hypotheses.** I, II; 1 unit. Prerequisite: Consent of instructor.

474. The Theory of Estimation. I, II; 1 unit. Prerequisite: Consent of instructor.
478. Topics in Statistics. I, II; 1 unit. Prerequisite: Consent of instructor.
491. Research and Thesis. I; 1 to 4 units. Prerequisite: Consent of instructor. STAFF.
492. Research and Thesis. II; 1 to 4 units. Prerequisite: Consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Fundamental Concepts of Mathematics. I; 1 unit. Prerequisite: One year of calculus or consent of instructor.
302. Fundamental Concepts of Mathematics. II; 1 unit. Prerequisite: One year of calculus or consent of instructor.
303. Foundations of Mathematics. I; 1 unit. Prerequisite: Consent of instructor.
304. Foundations of Mathematics. II; 1 unit. Prerequisite: Mathematics 303.
305. Teachers' Course. I, II; ½ to 1 unit. Prerequisite: A year of calculus or consent of instructor.
311. Advanced Algebra. For students interested in actuarial science, statistics, or teacher training in mathematics. I; 1 unit. Prerequisite: Mathematics 142 or consent of instructor.
312. Advanced Algebra. For students interested in actuarial science, statistics, or teacher training in mathematics. II; 1 unit. Prerequisite: Mathematics 142 or consent of instructor.
315. Linear Transformations and Matrices. I, II; 1 unit. Prerequisite: Mathematics 142.
317. Introduction to Higher Algebra. I; 1 unit. Prerequisite: Mathematics 132 and 142, or 137 and 147.
318. Introduction to Higher Algebra. II; 1 unit. Prerequisite: Mathematics 317.
327. Introduction to Higher Geometry. I; 1 unit. Prerequisite: Mathematics 132 and 142, or 137 and 147.
328. Introduction to Higher Geometry. II; 1 unit. Prerequisite: Mathematics 327.
332. Topological Spaces. I, II; 1 unit. Prerequisite: Credit or registration in Mathematics 347.
333. Combinatorial Topology. I, II; 1 unit. Prerequisite: Mathematics 343.
341. Differential Equations. I, II; 1 unit. Prerequisite: Mathematics 132 and 142, or 137 and 147.
342. Differential Equations. I, II; 1 unit. Prerequisite: Mathematics 341.
343. Advanced Calculus. I, II; 1 unit. Prerequisite: Mathematics 132 and 142, or 137 and 147.
345. Differential Equations and Orthogonal Functions. I, II; 1 unit. Prerequisite: Mathematics 132 and 142, or 137 and 147.
347. Introduction to Higher Analysis: Real Variables. I, II; 1 unit. Prerequisite: Mathematics 343 or consent of instructor.
348. Introduction to Higher Analysis: Complex Variables. I, II; 1 unit. Prerequisite: Mathematics 347.
349. Introduction to Higher Analysis: Real Variables II. I, II; 1 unit. Prerequisite: Mathematics 347.
353. Elementary Theory of Numbers. I; 1 unit. Prerequisite: Credit or registration in Mathematics 317 or 347.

54. **Elementary Theory of Numbers.** II; 1 unit. Prerequisite: Mathematics 317 or 353.

58. **Mathematics for Social Scientists.** I, II; ½ unit. Prerequisite: Mathematics 111 or 112. Only students in the social sciences receive credit for this course.

59. **Mathematics for Social Scientists.** I, II; ½ unit. Prerequisite: Mathematics 358. Only students majoring in the social sciences receive credit for this course.

61. **Theory of Probability.** II; 1 unit. Prerequisite: Mathematics 132 and 142.

62. **Finite Differences.** I; 1 unit. Prerequisite: Mathematics 142.

63. **Advanced Statistics.** I, II; 1 unit. Prerequisite: Mathematics 142 or 147.

64. **Advanced Statistics.** I, II; 1 unit. Prerequisite: Mathematics 363.

66. **Theory of Sample Surveys.** Same as Mass Communications 366. The development of the formulae to be used in the efficient planning of sample surveys and the interpretation of the results. I, II; 1 unit. Prerequisite: Differential and integral calculus and a first course in statistics.

67. **Practice of Sample Surveys.** Same as Mass Communications 367. Training in planning and making sample surveys; how the results are interpreted. One or more sample surveys are planned in detail. I, II; 1 unit. Prerequisite: Differential and integral calculus and a first course in statistics.

69. **The Ideas and Methods of Statistics.** The modern formulation of the ideas of statistical inference with applications to the testing of various statistical hypotheses. The treatment stresses, not the details, but the general nature of proofs. The interpretation of the ideas in practice is given. I, II; 1 unit. Prerequisite: Differential and integral calculus and a first course in statistics.

70. **The Ideas and Methods of Statistics.** Continuation of Mathematics 369. I, II; 1 unit. Prerequisite: Mathematics 369 or consent of instructor.

71. **Actuarial Theory.** I; 1 unit. Prerequisite: Mathematics 132 and 142, or 137 and 147.

72. **Actuarial Theory.** II; 1 unit. Prerequisite: Mathematics 371.

75. **Nonparametric Inference.** Nonparametric tests of hypotheses concerning means, variances, regression, and correlation of coefficients; methods depending on ranks; the efficiency of nonparametric tests. I, II; 1 unit. Prerequisite: Mathematics 361 or 363.

76. **Parametric Inference.** Introduction to the theories of estimation, testing hypotheses, and decision functions with respect to the parameters of distributions. The contributions of R. A. Fisher, J. Neyman, and A. Wald. The theory of the characteristic function is introduced as needed. I, II; 1 unit. Prerequisite: Mathematics 361 or 363.

77. **Sequential Inference.** An introduction to quality control, sampling inspection, and sequential analysis, with particular emphasis on the latter; control charts; single, double, and multiple sampling inspection methods; sequential probability ratio tests; efficiency of sequential tests; expected number of observations necessary; operating characteristic and average sample number curves. I, II; 1 unit. Prerequisite: Mathematics 363.

81. **Vector and Tensor Analysis.** I; 1 unit. Prerequisite: Mathematics 343, or equivalent, or consent of instructor.

82. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** II; 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

83. **Boolean Algebra and Its Applications to Digital Computer Design.** I, II; ½ to 1 unit. Prerequisite: Senior standing in mathematics, physics, or electrical engineering, or consent of instructor.

384. **Logical Design of Automatic Digital Computer Circuits.** Same as Electrical Engineering 384. I, II; 1 unit. Prerequisite: Senior standing; consent of instructor.

385. **Digital Computer Programming.** I, II; 1 unit. Prerequisite: Senior standing; consent of instructor.

386. **Laplace Transforms.** I, II; 1 unit. Prerequisite: Mathematics 343.

387. **Introduction to Numerical Methods.** I or II; 1 unit. Prerequisite: Mathematics 343.

388. **Mathematical Methods in Engineering and Science.** I or II; 1 unit. Prerequisite: Mathematics 343.

389. **Ordinary Non-Linear Differential Equations.** I, II; 1 unit. Prerequisite: Mathematics 343 and 341 or 345.

MECHANICAL ENGINEERING

(Including Industrial Engineering)

The Department of Mechanical Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. Advanced study and professional training are offered in the general fields of power, design, and production.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements for the degree of Bachelor of Science in mechanical engineering at the University of Illinois, together with a grade-point average of at least 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students on limited status will not be admitted to this department. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements, and their grade-point averages in graduate work are at least 4.0.

Courses numbered in the 300 group are those open to advanced undergraduate and graduate students, and those in the 400 group are for graduate students only. In registering for a course with variable credit, as one-half to one and one-half units, each student puts on his program card the number of units for which he intends to take the course. Courses numbered in the 300 group have variable credits of one-half to three-fourths unit; the one-half unit represents credit for work corresponding to advanced undergraduate study, the additional one-fourth unit requires a term paper.

Except under unusual circumstances the maximum number of credits which will be permitted in any course whose number ends in 8 or 9 will be three units toward the requirements for a master's degree. An additional four units of credit will be permitted for candidates working toward a doctor's degree. In most cases the research work conducted in these laboratory investigations can be reported in the thesis submitted for fulfillment of the requirements for each degree. A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived in exceptional cases, but a minimum of nine units is required if a thesis is not included.

For further information see the booklet "Graduate Study and Research in Mechanical Engineering." Copies may be obtained from the Department of Mechanical Engineering, Mechanical Engineering Building, Urbana, Illinois. Correspondence concerning graduate studies should be addressed to the Chairman of the Graduate Committee, Department of Mechanical Engineering.

ELLOWSHIPS AND ASSISTANTSHIPS

The Graduate College offers fellowships to worthy students, including those vho intend to specialize in mechanical engineering. In addition, the Department of Mechanical Engineering has industrial fellowships which vary in number from ear to year. Applications for Graduate College fellowships and industrial fellowhips should be sent to the Dean of the Graduate College.

A limited number of part-time teaching assistantships are available to students of superior attainment with either a Bachelor of Science or Master of Science legree in mechanical engineering. The stipend is $1,350 for a half-time assistant and $675 for a quarter-time assistant, for a school year of two semesters, and exemption from tuition, laboratory, library, and supply fees. A half-time assistant can carry up to three units of graduate work each semester. Application forms may be obtained from the Head of the Department of Mechanical Engineering.

A limited number of half-time research assistantships are offered by the Engineering Experiment Station. The recipients of these assistantships agree to hold them for two school years. The stipends and other terms are the same as those for teaching assistant. Application forms may be obtained from the Dean of the College of Engineering, 106 Civil Engineering Hall, Urbana, Illinois.

GRADUATE TEACHING FACULTY

Professors: N. A. Parker (Head of Department), E. L. Broghamer, W. N. Espy, J. R. Fellows, W. S. Harris, J. A. Henry, W. L. Hull, S. Konzo, H. H. Korst, R. F. Larson, R. J. Martin, D. G. Ryan, H. J. Schrader (cooperating), F. Seyfarth, K. J. Trigger.

Associate Professors: B. T. Chao, L. E. Doyle, G. W. Harper, L. C. Pigage, L. M. Zubko.

Assistant Professors: C. H. McClay, T. W. Price, E. I. Radzimovsky.

Instructor: R. H. Page.

Mechanical Engineering

COURSES FOR GRADUATES

401. **Thermodynamics.** Application of thermodynamics to the analysis and solution of engineering problems involving energy transfer and conversion. I; 1 unit. Prerequisite: One year course in thermodynamics. Espy.

402. **Thermodynamics of Gaseous Equilibrium.** Application of thermodynamics to analysis of combustion of gases used as working media in power production. II; 1 unit. Prerequisite: One year course in thermodynamics. Espy.

403. **Advanced Combustion.** A study of the theories of combustion. Solid, liquid, and gaseous fuels as used in engineering structures. Emphasis on experimental methods in combustion. I; 1 unit. Prerequisite: Undergraduate courses in thermodynamics and differential equations. Price.

404. **Gas Dynamics.** Properties of compressible fluids, subsonic and supersonic flow, steady and non-steady motion, one-, two-, and three-dimensional problems, shock waves, special problems in connection with combustion engines. I; 1 unit. Prerequisite: Differential equations, thermodynamics, and fluid mechanics. Korst.

405. **Heat Transfer.** Analysis of the methods and mechanisms of heat transfer: dimensional analysis method, design of heat exchangers, transient state heat transfer. Special problems in insulation and heat transfer. I; 1 unit. Prerequisite: Undergraduate course in heat transfer. Chao, Larson.

406. **Heat Conduction in Solids.** Fundamentals; general differential equation of heat conduction; methods of solution; steady state heat flow; transient heat

flow, one and two dimensions; periodic flow of heat; internal heat source in solids. I; 1 unit. Prerequisite: Undergraduate courses in heat transfer and differential equations. CHAO.

407. **Selected Topics in Gas Dynamics.** Theoretical analyses of non-steady processes including scavenging, pulse jet, shock tube, and the comprex. The course includes an introduction to high velocity laboratory techniques. II; 1 unit. Prerequisite: Mechanical Engineering 404. KORST.

408. **Laboratory Investigations in Thermodynamics.** Special investigations involving thermodynamic analysis, thermodynamic properties, and performance of physical and chemical systems. I, II; ½ to 1½ units. Prerequisite: One year course in thermodynamics and one-half year course in power laboratory. ESPY, KORST.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigations in flow, metering, heat transfer, heat exchanger performance and design. I, II; ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. CHAO, KORST, LARSON, PRICE, ZUBKO.

413. **Industrial Control Systems.** Study of basic elements of process control systems and process characteristics, particularly of thermal and mechanical processes. II; 1 unit. Prerequisite: Mechanical Engineering 311 or equivalent. MCCLAY.

421. **Heating and Air Conditioning.** Advanced study of heating, ventilating, and air conditioning. Factors affecting heat loss and heat gain of building, physiological effects of environment, equipment design of heat transfer equipment. Individual problems. I; 1 unit. Prerequisite: Undergraduate course in heating, ventilating, and air conditioning. FELLOWS, KONZO.

422. **Heating and Air Conditioning Design.** Factors affecting design of steam, hot water, and air systems, including pipe and duct design, heat transfer rates, and control of equipment. Special topics such as panel heating, electrical heating, radiant heating, reverse cycle refrigeration. II; 1 unit. Prerequisite: Undergraduate course in heating, ventilating, and air conditioning. FELLOWS, KONZO.

423. **Refrigeration Theory and Application.** Advanced study of processes and cycles; design problems; and special applications. II; 1 unit. Prerequisite: Undergraduate course in refrigeration. MARTIN.

428. **Laboratory Investigations in Refrigeration.** Special investigations in refrigeration. I, II; ½ to 1½ units. MARTIN and others.

429. **Laboratory Investigation in Heating and Air Conditioning.** Special investigations in heating, ventilating, and air conditioning. I, II; ½ to 1½ units. Prerequisite: Two semesters of power laboratory, or equivalent. FELLOWS, HARRIS, KONZO.

431. **Gas Turbines and Reaction Machines.** Analysis of gas turbine cycles, media, combustion, construction and operation, impulse and reaction machinery; heat exchange and insulation. II; 1 unit. Prerequisite: Undergraduate courses in thermodynamics, fluid mechanics, power equipment, and power laboratory. LARSON.

432. **Theory of Rotary Compressors.** Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbo-compressors; regulation; rotary positive blowers. II; 1 unit. Prerequisite: Undergraduate courses in thermodynamics and fluid mechanics (Mechanical Engineering 205 and 206; Theoretical and Applied Mechanics 232 or Aeronautical Engineering 211 and 212). KORST.

38. **Laboratory Investigations in Power Machinery.** Special investigations in power machinery, such as turbines, engines, fans, and compressors. I, II; ½ to 1½ units. Prerequisite: One year course in power laboratory. HULL and others.

41. **Machine Design.** A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper consideration of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines and one year of machine design. RYAN.

43. **Dynamics of Machinery.** A course complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, critical speeds, and vibrations in shafts; gyroscopic action in machines; flywheels, governors, and special topics. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines and one year of machine design. BROGHAMER, RYAN.

45. **Design of Internal Combustion Engines.** Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determination of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines, one year of machine design, and undergraduate course in internal combustion engines. HULL.

48. **Laboratory Investigations in Machine Design.** Special investigations in machine design. I, II; ½ to 1½ units. BROGHAMER, RADZIMOVSKY, RYAN.

51. **Metal Cutting.** A study of the various factors involved in metal cutting and forming. Basic mechanics of machining processes including consideration of tool-chip friction and dynamic flow stress in the material. Study of the temperatures developed during cutting and forming; distribution and effect of temperatures upon the cutting or forming process. Heat balance in high-speed metal cutting and effects on tool life, surface finish, and dimensional accuracy of the work. I; 1 unit. Prerequisite: Undergraduate courses in advanced metal processing and either heat treatment of metals or physical metallurgy. TRIGGER.

8. **Laboratory Investigations in Production.** Special investigations in the field of production, particularly in materials processing, metal cutting, and production engineering. I, II; ½ to 1½ units. HARPER, PIGAGE, TRIGGER.

8. **Laboratory Investigations in Railway Mechanical Engineering.** Special investigations in the field of railway mechanical engineering. I, II; ½ to 1½ units. Prerequisite: Bachelor of Science degree in mechanical engineering. SCHRADER.

1. **Thesis (M.S. or Ph.D.).** I; ½ to 4 units. STAFF.

3. **Seminar.** Presentation and discussion of significant developments in mechanical enginering. I, II; no credit. KONZO.

URSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

5. **Thermodynamics of High-Velocity Flow.** The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines. I, II; ½ to ¾ unit. Prerequisite: Mechanical Engineering 206 or consent of instructor. ZUBKO.

311. **Instrumentation and Measurements.** Instruments and measuring equipmen for flow, temperature, pressure, speed, and gas analysis. I, II; ½ to ¾ uni Konzo, McClay.

314. **Lubrication.** The theories of lubrication; manufacture and properties c lubricants; methods of testing; lubrication methods and appliances. A stud of the lubrication requirements of machines of many kinds. I; ½ to ¾ uni Prerequisite: Undergraduate courses in machine design and fluid mechanic Radzimovsky.

332. **Theory of Internal Combustion Engines.** Study of thermodynamics c reciprocating engine cycles, considering such factors as chemical dissociatio heat loss, combustion chamber shape, and flow through valves and manifold II; ½ to ¾ unit. Prerequisite: Undergraduate course in internal combustio engines. Hull.

346. **Power Plant Design.** A design course covering the selection of equipmen and problems involved in the design and layout of a modern plant. II; to ¾ unit. Prerequisite: Undergraduate courses in machine design an power. Seyfarth.

361. **Railway Motive Power Equipment.** A technical study of the various typ of motive power used on railways with special emphasis on steam, Diesel, an electric locomotives, and secondary consideration to special types such as th steam turbine, turbo-electric and gas turbine locomotives. I; ½ to ¾ uni Schrader.

362. **Railway Motive Power Operation.** A study of the conditions under whic railway motive power operates; economics of operation, present equipmen proposed new equipment, servicing, and maintenance; availability; trai resistance, motive power tractive force, speed time and distance curves, prep ration of time tables; problems in stopping trains; terminal and repair faci ties. II; ½ to ¾ unit. Schrader.

Industrial Engineering

COURSES FOR GRADUATES

453. **Methods and Measurements of Industrial Work.** Advanced theoretical anal sis of factors affecting determination of economical methods, method stan ards, and time standards for industrial operations. Special investigatio and term paper. I; 1 unit. Prerequisite: Undergraduate course in moti and time study, and production control. Pigage.

454. **Production Engineering.** Advanced consideration of production engineeri principles as related to cost analysis and reduction, control of flow of wo in manufacture, evaluation of performance against standard, and compe sation. Special investigations. II; 1 unit. Prerequisite: Mechanical En neering 453. Pigage.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

350. **Tool Engineering Analysis.** Analysis and solution of problems by analytic methods with special attention to dimensional planning and economic l size. Design of tools for metal forming and shearing. II; ½ to ¾ unit. Pr requisite: Undergraduate course in tool engineering. Doyle.

358. **Problems in Industrial Safety.** Detailed study of the principles of indu trial (and related) accident prevention and their application. Designed provide a sound working knowledge of safety principles for students i terested in entering the field of safety engineering in industry. Topics inclu development of industrial safety movement including accident costs, accide

sources and causes, and responsibility of management; appraising safety performance by safety inspection, job safety analysis, and accident investigation; planning and arranging for safety in production engineering; training, supervision, and organization; industrial hygiene; common hazards including explosions, fires, fumes, and electrical devices. Special investigations. I or II; ½ to ¾ unit. Prerequisite: Consent of instructor. HARPER.

359. **Fire Protection.** Technical study of fire protection covering applications and techniques based on engineering analysis. Topics include fire losses in industry, occupancy fire hazards, control of fire, construction for fire protection, water supplies, public fire departments and industrial fire brigades, and hazardous materials. I and II; ½ to ¾ unit. Prerequisite: Senior standing in engineering or consent of instructor. HARPER.

MINING AND METALLURGICAL ENGINEERING

The Department of Mining and Metallurgical Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. The prerequisite for graduate work with metallurgical engineering or mining engineering as a major is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in the major field of study at the University of Illinois. A student who is deficient in background and previous training may be required to register in certain undergraduate courses (without graduate credit) as a prerequisite to graduate work. At the end of the student's first registration his adviser will enter on a "Memorandum of Prerequisites" the undergraduate courses necessary for the student to complete. The departmental scholastic requirements for admission to graduate study on full standing, advanced standing, and limited status are given on page 13.

A candidate for the degree of Master of Science is ordinarily required to have a minimum of eight units of graduate work, including a thesis. However, a degree will not be granted for this minimum if a student receives one unit of C unless he also receives one unit of A, or to one who receives more than one unit of C. Additional work will be required of a student who does not meet this standard.

If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work will be required.

The thesis requirement will not be waived for research assistants or, in general, for assistants on research projects. For research assistants and others on half-time status, a minimum length of residence of three semesters will be required for a master's degree, regardless of the number of units of credit obtained.

In addition to the general requirements of the Graduate College for the degree of Doctor of Philosophy in Engineering, certain departmental requirements are applicable. The languages ordinarily required of a candidate in metallurgical or mining engineering are French and German. With the approval of the department, a student may petition to the Executive Faculty requesting permission to substitute Russian for the French language examination if it can be shown that in the student's special field of research the literature available in the substituted language is more significant.

The thesis subject, approved by the adviser, must be announced at or before the beginning of the third year of study. The student must choose an acceptable subject for his thesis before he can take the preliminary examination.

Before a candidate is admitted to the oral preliminary examination, he is required to pass a series of written preliminary examinations given several weeks in advance of the oral preliminary examination. The examinations need not be based on formal course work alone, but are intended to determine the student's

knowledge of his entire field including his knowledge of previous work, history and practice in his field of specialization.

A candidate for the degree of Doctor of Philosophy is required to pursue major in the subject in which his research lies. He is also required to choose on or two minor subjects. If one minor only is chosen it must be taken in a depart ment of study other than that of the major, and credit for it may be earned b work representing not less than four units (a total of twenty-four units of gradu ate work is required for the doctorate). If two minors are chosen, one must b closely related to the major, and the second minor (not less than two units) mus be taken in a department of study other than that of the major or first minor Acceptable minors, unless special permission is granted by petition, will be fror the following subjects: physical chemistry, analytical chemistry, geology, mathe matics, theoretical and applied mechanics, and physics.

The department publishes a brochure, entitled "Graduate Study and Re search in Mining and Metallurgical Engineering," which gives further detail about departmental requirements for graduate study. Copies may be secured b addressing the Head of the Department of Mining and Metallurgical Engineering

FELLOWSHIPS AND ASSISTANTSHIPS

A number of graduate fellowships in mining engineering have been establishe by the Sahara Coal Company. One or more are awarded each year on recom mendation of the Department of Mining and Metallurgical Engineering. The are for one to three years of graduate study and research in coal-mining engineer ing. The stipend is $700 for first-year, $850 for second-year, and $1,000 fc third-year fellowships.

The Union Carbide and Carbon Research Laboratories Fellowship, with a annual stipend of $1,400 to $2,100 (depending upon marital status and previou experience), is awarded to second- and third-year graduate students in meta lurgical engineering. Union Carbide and Carbon fellows act as research assistan to Professor Paul A. Beck in his research program in physical metallurgy.

One fellowship is offered annually by Olin Industries, Inc., to a second- c third-year graduate student in metallurgical engineering for research in titaniu and its alloys. It is awarded with a stipend of $850 for second year and $1,00 for third year of study, on recommendation of the head of the Department c Mining and Metallurgical Engineering.

A number of research assistantships on one-half time or one-quarter tim basis are available to graduate students in mining or metallurgical engineerin The stipend is $1,350 for a half-time assistant and $675 for a quarter-tim assistant, for a school year of two semesters, and exemption from tuition, labor tory, library, and supply fees. A half-time assistant may carry up to three units c graduate work each semester. It is usually possible to assign an assistant to duti in the field of his special interest. Inquiries concerning these positions should b directed to the Head of the Department of Mining and Metallurgical Engineerin

GRADUATE TEACHING FACULTY

Professors: T. A. Read (Head of Department), P. A. Beck, W. R. Chedse W. H. Voskuil.

Associate Professors: E. J. Eckel, A. C. Forsyth, B. G. Ricketts, C. A. Wer

Assistant Professor: R. G. Wuerker.

Mining Engineering

COURSES FOR GRADUATES

401. Advanced Mineral Dressing and Coal Preparation. Advanced theory an practice of mineral dressing and coal preparation processes. I or II; 1 uni Chedsey.

02. **Mine Valuation, Taxation, and Mineral Economics.** A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. I or II; 1 unit. CHEDSEY.

03. **Advanced Mine Administration.** Current methods and systems of mine administration in use by major mining corporations. I or II; 1 unit. CHEDSEY.

05. **Advanced Mine Ventilation.** Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. I; 1 unit.

06. **Design of Underground Mines.** Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. II; 1 unit. Prerequisite: Mining Engineering 253.

91. **Research in Mining Engineering and Mineral Dressing.** Individual research in some phase of the general field of mining engineering and under the supervision of a member of the staff. Results of research may be used for graduate thesis. I, II; ½ to 4 units. CHEDSEY.

92. **Research in Mining Engineering and Mineral Dressing.** Individual research in some phase of the general field of mining engineering and under the supervision of a member of the staff. Results of research may be used for graduate thesis. I, II; ½ to 4 units. CHEDSEY.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

02. **World Mineral Economics.** The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. II; ¾ to 1 unit. VOSKUIL.

04. **Mine Safety Engineering.** A detailed study of mine accident statistics, causes of accidents, accident prevention; calculation of insurance rates and cost of mine accidents; psychology of accident prevention; state and federal mining laws as related to safety. I; ¾ unit. Prerequisite: Mining Engineering 253.

51. **Geophysical Prospecting.** Same as Geology 351. Principles of geophysics and their application to mining processes. I; 1 unit. Prerequisite: Consent of instructor. WUERKER.

54. **Mining Geology.** Same as Geology 354. Structure and occurrence of mineral deposits in relation to prospecting, exploration, development, and exploitation. II; 1 unit. Prerequisite: Geology 101 or 150, 130 or 131, and Mining Engineering 201 or 230, or consent of instructor.

96. **Seminar.** Review of mining literature; reports; technical writing. II; ¼ unit. CHEDSEY.

Metallurgical Engineering

OURSES FOR GRADUATES

01. **Advanced Physical Metallurgy.** Interpretation and experimental determination of multielement phase diagrams with the emphasis on ternary systems. I or II; 1 unit. Prerequisite: Equivalent of the undergraduate courses required in metallurgical engineering. ECKEL.

02. **Advanced Metallographic Technique.** Advanced study of metallographic laboratory procedure. I; 1 unit. RICKETTS.

04. **Stainless Steels and High Temperature Alloys.** Classification of stainless steels into three major classes; martensitic, ferritic, and austenitic. A detailed study is made of each class. The high temperature alloys are conveniently

studied in four groups, namely, iron base, nickel base, cobalt base, and miscellaneous in which molybdenum plays an important role. II; 1 unit. Forsyth.

405. **Advanced Physics of Metals.** Elementary concepts of quantum mechanics the structure of the atom; assemblies of atoms. I; 1 unit. Wert.

406. **Advanced Physics of Metals.** The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. II; 1 unit. Prerequisite: Metallurgical Engineering 405. Wert.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of the changes produced by deforming and annealing metals and alloys; stereographic projection, deformation, and annealing textures. I; 1 unit. Beck.

408. **Solubility and Precipitation Phenomena in Metals.** Solid solubility limits in binary and ternary systems; solubility of gases in liquid metals; precipitation of gases and of solid phases; crystallography and mechanism of precipitation hardening; grain boundary reaction; effect of small additions of other elements. II; 1 unit. Beck.

491. **Research in Metallurgy.** Individual research in specialized problems and under supervision of members of staff. Results of research may be used for graduate thesis. I, II; ½ to 4 units. Staff.

492. **Research in Metallurgy.** Individual research in specialized problems and under supervision of members of staff. Results of research may be used for graduate thesis. I, II; ½ to 4 units. Staff.

497. **Research Seminar.** Graduate students present the results of their own research work and the results of recently published research by other investigators principally in the fields of recovery, subgrains, recrystallization, grain growth, textures, and alloys of the transition elements. I, II; ¼ unit. Beck.

498. **Colloquium in Physical Metallurgy.** Review of current metallurgical research in other laboratories, by visiting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. I; no credit.

499. **Colloquium in Physical Metallurgy.** Review of current research literature and departmental research program. Graduate students present thesis research. Required of all graduate students in metallurgical engineering. II; no credit.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Powder Metallurgy.** Production of powder metals; fabrication of metal shapes from powder metals; compacting, sintering, testing, and application of powdered metal shapes. II; ¾ or 1 unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 304. Eckel.

304. **Powder Metallurgy Laboratory.** Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. II; ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302. Eckel.

305. **Metallurgy of Steel Castings.** Technical and metallurgical control in the production of steel castings; acid and basic furnace practices; control of slag in steel making; heat treatment and metallography of steel castings. I, II; ¾ or 1 unit. Prerequisite: Metallurgical Engineering 205, 208, and 210. Forsyth.

308. **Metallurgical Kinetics and Thermodynamics.** Fundamental thermodynamic considerations and application of thermodynamics to metallurgical problems.

II; ¾ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Chemistry 246. STAFF.

09. **Mechanical Behavior of Metals.** The fundamental properties of metal crystals are studied with particular emphasis on electrical, thermal, and elastic properties; the fundamentals of crystal plasticity; slip, twinning, dislocations in single and polycrystals; the anelastic properties of metals with emphasis on internal friction. I; 1 unit. WERT.

10. **Kinetics of Phase Changes in Metals.** Diffusion in metals; the role of diffusion in processes important in metallurgy; nucleation and kinetics of phase changes in metal; examples of phase changes and their importance; the precipitation hardening systems. II; 1 unit. WERT.

MUSIC

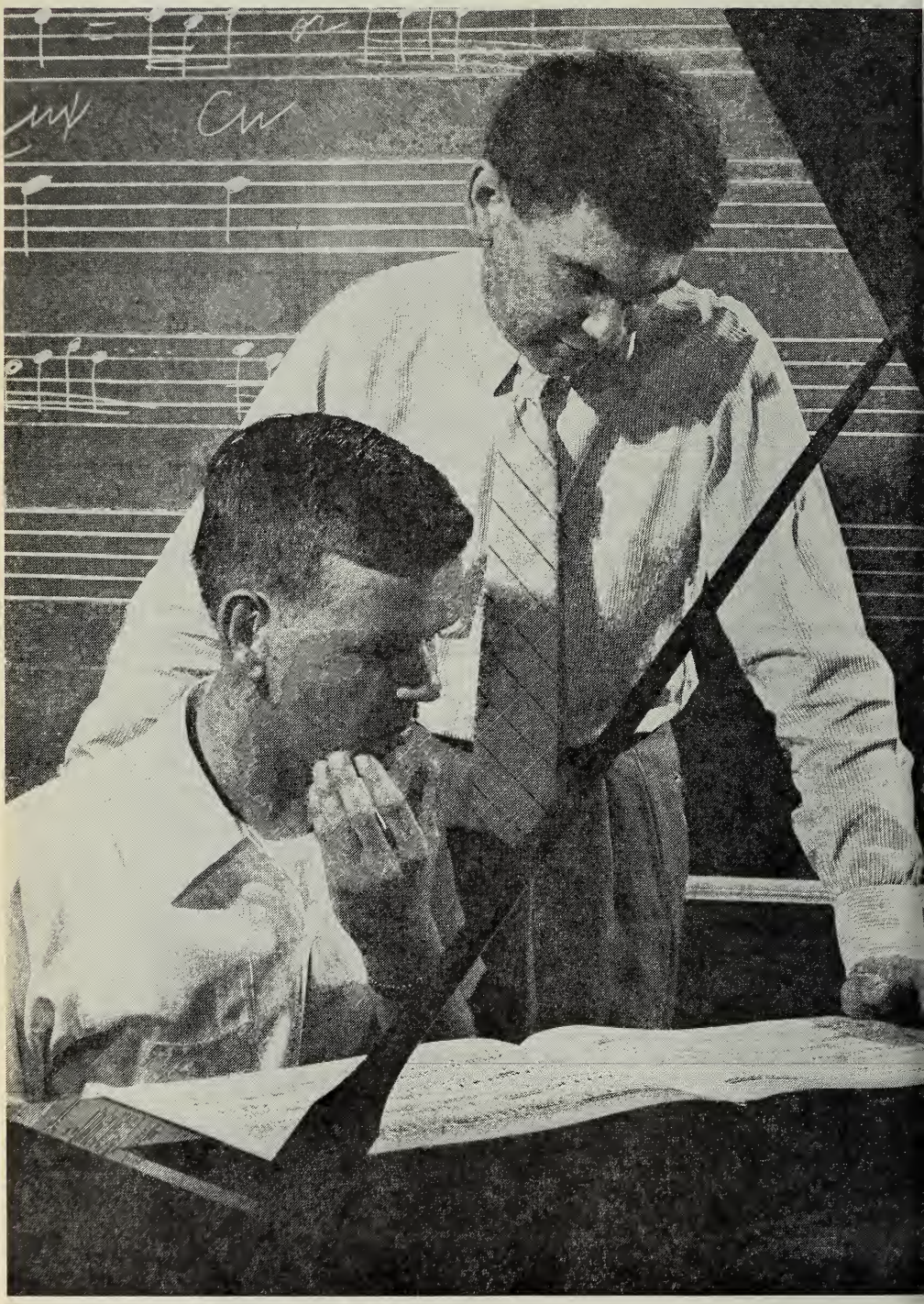
The School of Music offers the degrees of Master of Music, Master of Science in Music Education, Advanced Certificate in Music Education, Doctor of Education with a major in Music Education, and Doctor of Philosophy in Musicology. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music.

Degree of Master of Music. For the degree of Master of Music, the major field may be in musicology, music theory and composition, music literature, applied music (organ, voice, piano, violin, cello), or band and orchestra instruments.

The admission requirement, in terms of grade-point average, is at least 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

In addition, an applicant for admission to graduate study in music is required (1) to have finished successfully a four-year undergraduate curriculum in music or music education, or their equivalent in hours and content, from an institution which holds membership in the Association of American Universities, or from a liberal arts college recognized by the North Central Association or equivalent regional accrediting association, or from an independent conservatory or school of music whose four-year undergraduate curricula represent the equivalent in hours, content, and attainment as those offered at the University of Illinois; and (2) to pass a qualifying examination in the major field of concentration to be administered by the Graduate Committee of the School of Music. If the major is to be applied music or band and orchestra conducting, this examination is essentially one of performance on the major instrument and is given at specified times during the year. If an applicant is unable to appear before the Graduate Committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present writings or other evidence to the committee of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of both German and French is desirable. Each applicant will furnish the Graduate Committee of the School of Music a copy of his official undergraduate transcript.

Degree of Master of Science in Music Education. Candidates for the degree of Master of Science in Music Education must earn four units in music, three and one-half of which are electives, two units in education, and two units in electives. Requirements are Music 443, one-half unit; music electives, three and one-half units; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives must be selected with the approval of the adviser. Three electives must be in music, and the other two in music, in education, or in exceptional cases, in other fields. The grade-point



Ornamentation in music for the harpsichord as discussed in Col
Musicum.

average required for admission is the same as that required by the department. Limited status students are not admitted to this program.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the Certificate will not be considered as beginning work leading to the degree of Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have maintained a 4.0 average in all previous graduate work. He must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations will be administered in music theory and applied music to determine the candidate's level of proficiency in those areas. A candidate whose level of proficiency is below that required by the University of Illinois for the Bachelor of Science degree in Music Education will be required to take work in addition to the course work prescribed under Program.

Residence. The minimum residence requirement is one semester during which a minimum of three units is successfully completed, or two summer sessions during each of which a minimum of two units is successfully completed. All work for the Certificate may be completed in summer sessions.

Program. A minimum of eight units of course work beyond the master's degree is required. All of the course work must be taken on the Urbana campus of the University. Music 440 and 441 and either Education 411 or 412 are required. The remainder of the program will be based upon the student's needs and interests and upon the deficiencies revealed in placement tests. No more than one unit of applied music may be counted toward the Certificate. With the prior approval of an adviser, courses in music which carry undergraduate numbers may be approved for credit. Such credit will be computed at the rate of one-quarter unit per each semester hour of credit. No such credit can be counted toward the requirements of the degrees of Master of Science in Music Education and Doctor of Education with a major in music education.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed will be required to take courses sufficient to meet the certification requirements.

Degree of Doctor of Education. The program leading to the degree of Doctor of Education with a major in music education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission will be determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations administered by the School of Music will include music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in music courses, and six units of credit in education courses. No more than one unit of credit in applied music may be counted toward the degree. Students found deficient in applied music will be expected to correct the deficiency in addition to the prescribed course work.

The following courses are required: Education 410, 415, Music 440, 441. The remainder of the program will be planned for each candidate in terms of present and future professional needs and interests. Extramural course work may not be included as part of this sixteen-unit requirement. A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the degree of Doctor of Education with a music education major. A student may, with the approval of the advisers, plan a maximum of four units of work to be accomplished at other accredited institutions. No more than six units of credit earned at other universities may be included in the minimum sixteen-unit requirement.

A preliminary examination in music and education must be completed prior to the beginning of the dissertation. A student who has completed a minimum of eight units of course work subsequent to his admission may take the preliminary examination when it is recommended by his advisers. The preliminary examination is given by a committee composed of representatives from the School of Music and the College of Education appointed by the Dean of the Graduate College. The nature of the examination will be determined by the committee. Part of the examination may be written. Part of it must be oral. Prior to admission to the preliminary examination the student is expected to demonstrate broad competence in professional education and in music and music education. Competence may be demonstrated by a grade of B or better in appropriate courses or by satisfactory completion of proficiency examinations.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

A final oral examination is held at least two weeks prior to the date the degree is conferred. The examination committee is appointed by the Dean of the Graduate College and should include representatives from both the School of Music and the College of Education. The final examination is primarily concerned with a report of the thesis study, but also extends over the whole field of the candidate's study.

Upon satisfactory completion of all degree requirements in both the School of Music and the College of Education, the candidates will be recommended for graduation by the School of Music.

Degree of Doctor of Philosophy in Musicology. The degree of Doctor of Philosophy in Musicology is offered in such fields of music as merit and demand research methods. It is intended for applicants whose interest lies in research in the history of music, theory of music, psychology of music, comparative musicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Grad-

uate College (see page 13), an applicant must obtain the recommendation of the Graduate Committee of the School of Music in order to be admitted to the program leading to the degree of Doctor of Philosophy. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the degree of Master of Music with a major in musicology or theory of music; (2) have acquired an adequate background in those areas of the liberal arts and sciences relevant to his studies; (3) have promise of superior ability and outstanding achievement, qualities commonly expressed by an average of higher than 4.25 in the student's previous graduate work, though other indications will be evaluated; but in no case will admission to the doctoral program be granted to a student who has maintained a graduate average of less than 4.0, or who has had the equivalent of two units of work below B in his previous graduate study; (4) be adequately prepared to pursue the doctoral program as determined by examinations administered by the Graduate Committee of the School of Music, including examinations in applied music, theory of music, and history of music. An unsatisfactory showing in any of these examinations by an applicant who meets other prerequisites may lead to provisional acceptance, but such students will be expected to pass all examinations during their first year of work.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the minimum of twenty-four units of graduate credit necessary to earn the degree of Doctor of Philosophy will be in Music 429 and will be devoted to the completion of an original doctoral thesis subsequent to the official admission of the student to candidacy. Admission to candidacy will be recommended only after successful completion of the following: (1) Sixteen units of graduate credit, or their equivalent, in courses including Music 314, 321 or 322, 422, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in applied music. Credit for units not in music will be granted toward the Ph.D. only where approved by the Graduate Committee as relevant to the student's field of specialization. (2) A minimum of two units each in one or two of the following minor fields: history, philosophy, psychology, related arts, English or other literature, sociology, classics, anthropology, acoustics, electrical engineering, journalism, or education. Other minor fields may be accepted upon recommendation of the major adviser. (3) In addition to the general foreign language requirements of the Graduate College, an examination in one or more additional foreign languages when, in the opinion of the Graduate Committee, such ability is necessary for proper research in the student's field of concentration. (4) A preliminary examination administered by a committee appointed by the Dean of the Graduate College. This examination will consist of a written examination on the history of music; a written examination in the area of the student's field of concentration; the submission, at least a month prior to the written examinations, of a score of a free composition, a fugue, or an instrumentation project, of a nature approved by the Graduate Committee of the School of Music; and an oral examination on the general field of musicology and on the content of the written examinations.

GRADUATE TEACHING FACULTY

Professors: D. A. Branigan (Director of the School of Music), B. Bergethon, S. Fletcher, B. R. Foote, M. H. Hindsley, H. Kessler, J. M. Kuypers, R. H. Miles, P. Rolland, S. Schoonmaker, Jane C. Watt, P. Young.

Associate Professors: Dorothy E. Bowen, B. M. Goodman, L. R. Hamp, K. Kellogg, W. Kuhn, C. Leonhard, P. Painter, P. S. Pet-

tinga, B. Phillips, W. L. Roosa, H. C. Schmitt, H. O. Sexton, S. Stravinsky, R. H. Swenson, Edith Usry, G. R. Waller, E. H. Weigel, Velma K. Wilson, L. E. Zirner.

Assistant Professors: J. Allen, G. W. Binkerd, Beth Bradley, A. M. Carter, Dorothy E. Clark, J. C. Garvey, G. Hunter, J. R. Kelly, E. D. Kisinger, D. A. Ledet, A. J. McDowell, W. Miller, P. W. Price, Claire L. Richards, L. A. Starr, J. M. Ward, Grace Wilson.

Instructors: E. S. Berry, W. Coggins, C. O. DeLaney, P. Farrell, T. L. Holden, E. Krolick, C. Palisca.

COURSES FOR GRADUATES

400. **Advanced Instrumentation — Chamber and Symphonic.** Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. I; ½ to 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. **Advanced Instrumentation — Band.** Arrange for the concert band works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. II; ½ to 1 unit. Prerequisite: Undergraduate instrumentation. Hindsley.

402. **Analysis in Relation to Performance and Interpretation, I.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. I; 1 unit. Prerequisite: Music 104 or equivalent, or consent of instructor. Leonhard.

403. **Analysis in Relation to Performance and Interpretation, II.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. II; 1 unit. Prerequisite: Music 402. Leonhard.

406. **Composition.** Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. I, II; ½ to 1½ units. Kessler, Phillips.

410. **History of Music Theory, I.** A study of selected theoretical treatises written before 1400. I; ½ to 1 unit. Offered in 1954-1955 and in alternate years. Ward.

411. **History of Music Theory, II.** A study of selected theoretical treatises written after 1400. II; ½ unit. Offered in 1954-1955 and in alternate years. Ward.

412. **History of Musical Esthetics, I.** A survey of the principal philosophies of music, their historical backgrounds and their relation to musical styles. From Pythagoreanism to the humanistic period. I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: graduate standing in music. Palisca.

413. **History of Musical Esthetics, II.** A survey of the principal philosophies of music, their historical backgrounds and their relation to musical styles. From the seventeenth century to the present day. II; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Music 412. Palisca.

414. **Notation, I.** The history of notation from its beginning to 1400. I; 1 unit. Prerequisite: Graduate standing or consent of instructor.

415. **Notation, II.** The history of notation from 1400 to 1600, including instrumental tablatures. II; 1 unit. Prerequisite: Music 414 or consent of instructor.

416. **History of Instrumental Music to 1600.** A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Music 312. WARD.

417. **History of Instrumental Music from 1600 to 1750.** A study of instrumental music in the Baroque era. II; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Music 416 or consent of instructor. WARD.

418. **The Origins and the History of Opera up to Gluck.** The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory and esthetics of opera. The principal composers covered will be Monteverdi, Cavalli, Cesti, Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Music 312. PALISCA.

420. **Seminar in Music Literature.** Intensive study of outstanding works selected from all fields of music literature. Required of all students enrolled in the Doctor of Musical Arts program. I, II; 1 unit; maximum accumulated credit, 2 units. WARD.

421. **Seminar in Music Education.** This course is designed to introduce graduate students in music education to the methods of research and the planning of professional projects. The work includes lectures, critical analysis of professional projects, and the presentation of preliminary reports on student projects. I, II; 1 unit. BERGETHON.

422. **Seminar in Theory of Music.** Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. I, II; ½ to 1 unit. KESSLER.

423. **Seminar in Musicology.** Problems in historical and systematic musicology. Discussions of special problems and reports on individual research. I, II; 1 unit.

424. **Bach, I.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. I; 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music degree. MILES.

425. **Bach, II.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. II; 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music degree. MILES.

426. **Beethoven, I.** I; 1 unit. Offered in 1955-1956 and in alternate years.

427. **Beethoven, II.** II; 1 unit. Offered in 1955-1956 and in alternate years.

428. **Problems and Methods.** A survey of the general field of advanced studies in music, and of techniques of research and presentation of results. Each student will undertake reports on projects pertaining to his interests and will consult with the staff. In weekly seminar sessions reports will be read, discussed, and criticized. I, II; ½ unit. Prerequisite: Graduate standing in music. PALISCA and staff.

429. **Thesis and Research.** I, II; ½ to 4 units. BERGETHON, BRANIGAN, HINDSLEY, KELLOGG, KESSLER, LEONHARD, MILES, PALISCA, WARD, V. WILSON.

430. **Advanced Orchestra Conducting and Literature.** II; 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. GOODMAN.

431. **Advanced Band Conducting and Literature.** I; 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Conducting, Literature, and Administration.** Deals with the training and conducting of choral groups, including musical and organizational problems. I or II; 1 unit. YOUNG.

433. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. I; 1 unit. Prerequisite: Bachelor's degree with major experience in band and/or orchestra. KISINGER.

434. **Piano Literature.** I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree, and qualifying examination given by the graduate committee. KESSLER.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree, and qualifying examination given by the graduate committee. KELLOGG.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree, and qualifying examination given by the graduate committee. MILES.

437. **String Instrument Literature.** I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree, and qualifying examination given by the graduate committee. ROOSA.

438. **Wind Instrument Literature.** An integrating course, offering the opportunity to survey, at the graduate level, the field of solo and ensemble wind literature. The material includes analysis and performance when possible, of the music itself, recordings, and collateral readings. I, II; 1 unit; maximum accumulated credit, 2 units. KISINGER, LEDET.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis placed on current trends in educational thought and their implications for music education. I; ½ unit. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. II; ½ unit. LEONHARD.

442. **The General Music Program in Secondary Schools.** A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. I or II; ½ unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. **Administration and Supervision of Music Education.** II; ½ unit. Prerequisite: Bachelor of Science degree in music education or in education with a music major, or Bachelor of Music degree, including music education courses. BERGETHON.

444. **Audio-Visual and Scientific Aids in Music Education.** A survey of audio-visual equipment and materials is carried on with emphasis upon applications to music education. Special emphasis is given to the development of new techniques and uses of audio-visual aids in the teaching and study of music. Research studies in this field are examined, and the need for further

research is emphasized. I; 1 unit. Prerequisite: Physics 332 (Physics of Sound), graduate standing, or consent of instructor. KUHN.

445. **Music in Higher Education.** An orientation to the organization, teaching, and administration of music in the college and university. I or II; ½ unit. Prerequisite: Graduate standing in music education. BERGETHON.

480. **Piano.** I, II; ½ to 1 unit. Prerequisite: Bachelor of Music degree and successful completion of a qualifying examination given by the graduate committee. APPLIED MUSIC FACULTY.

481. **Voice.** I, II; ½ to 1 unit. Prerequisite: Bachelor of Music degree and successful completion of a qualifying examination given by the graduate committee. APPLIED MUSIC FACULTY.

482. **Organ.** Selected studies from the masterworks of organ literature. I, II; ½ to 1 unit. Prerequisite: Bachelor of Music degree and successful completion of a qualifying examination given by the graduate committee. APPLIED MUSIC FACULTY.

483. **Violin.** I, II; ½ to 1 unit. Prerequisite: Bachelor of Music degree and successful completion of a qualifying examination given by the graduate committee. APPLIED MUSIC FACULTY.

484. **Cello.** I, II; ½ to 1 unit. Prerequisite: Bachelor of Music degree and successful completion of a qualifying examination given by the graduate committee. APPLIED MUSIC FACULTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Counterpoint, I.** Creative writing in linear counterpoint of the following: rounds, instrumental and vocal; canons; inventions; and fugues. Analysis of Bach inventions and the *Well-Tempered Clavier*. I; ½ unit. Prerequisite: Music 104. KELLY, WEIGEL.

301. **Advanced Counterpoint, II.** Creative writing in linear counterpoint of the following: rounds, instrumental and vocal; canons; inventions; and fugues. Analysis of Bach inventions and the *Well-Tempered Clavier*. II; ½ unit. Prerequisite: Music 300. KELLY, WEIGEL.

302. **Fugue, I.** Systematic practice in writing the various parts of the fugue, together with analysis of fugues by Bach and Handel. I; ½ unit. Prerequisite: Music 104 and/or consent of instructor. HUNTER, KELLY, PHILLIPS.

303. **Fugue, II.** Continuation of Music 302 and including the writing of complete fugues and analysis of fugal composition of the nineteenth and twentieth centuries. II; ½ unit. Prerequisite: Music 302 and/or consent of instructor. HUNTER, KELLY, PHILLIPS.

304. **Analytical Techniques, I.** Examination of music from plain song and the earliest polyphony to the close of the sixteenth century. Emphasis is placed upon penetration of the compositional techniques used, and includes the study of form and harmony as these bear on the problems. I; ½ unit. Prerequisite: Music 104 or consent of instructor. PHILLIPS.

305. **Analytical Techniques, II.** Continuation of Music 304, beginning with the early seventeenth century and coming down to the present day. II; ½ unit. Prerequisite: Music 304 or consent of instructor. PHILLIPS.

306. **Composition.** Work in original composition including the small and large homophonic forms. I, II; ½ or 1 unit. Prerequisite: Music 107 and/or consent of instructor. BINKERD, KELLY, KESSLER, PHILLIPS, WEIGEL.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. I; ½ unit. Prerequisite: Music 112. ROOSA.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. II; ½ unit. Prerequisite: Music 312. Roosa.

312. **Music of the Baroque and Classical Periods.** A history of music from about 1600 to 1800. I; ½ unit. Prerequisite: Music 311. Palisca.

313. **Music of the Nineteenth and Twentieth Centuries.** A history of music from about 1800 to the present. II; ½ unit. Prerequisite: Music 312. Palisca.

314. **History of Performance Practices.** Study of the history of performance practices including the preparation of appropriate historical material for performance. I, II; ½ unit. Hunter.

315. **Contemporary Music.** A survey of all important trends, forms, and styles of modern music from 1875 to the present. I, II; ½ unit. Prerequisite: Junior standing and/or consent of instructor. Phillips.

320. **Proseminar.** A course providing special preparation in the specialized fields of musicology, theory, and composition. I, II; ½ unit; maximum credit, 1 unit. Prerequisite: Senior or graduate standing in music; consent of instructor. Ward.

321. **Music Bibliography and Reference.** Detailed study of the basic and most useful reference and bibliographic aids. Practice problems in the use of specific titles and in how to find materials in the library are given. Music, books about music, and recordings of music are included in the course. I or II; ½ unit. Prerequisite: For students in the School of Music, senior standing or consent of instructor; for non-music students, senior standing with at least one year each of music history and music theory at the college level, or equivalent. Allen.

322. **Introduction to Musicology.** A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. I, II; ½ unit.

330. **Applied Music Pedagogy.** Survey of techniques, practices, and materials. Presentation of group and individual instruction. An approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. I, II; ½ unit. Prerequisite: Junior standing or consent of instructor. Bradley, Fletcher, Rolland.

342. **Percussion Methods.** Designed primarily for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. I or II; ½ unit. Prerequisite: Senior or graduate standing in music education; Music 196 and 256, or equivalent. Price.

344. **Methods of String Class Teaching.** This course is designed primarily for teachers of school music who are not performers on a string instrument yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Consent of instructor. Waller.

345. **Teaching of Theory and Harmony.** Techniques and materials used in the teaching of theory of music in senior high school and junior college. I; ½ unit. Prerequisite: Music 300 or consent of instructor. Carter.

346. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study will be the preparation of resource materials for music programs in elementary and secondary schools. S; 1 unit. Bergethon, Leonhard.

350. **Advanced Chamber Music.** Selected projects in chamber music on the

advanced level for qualified students. I, II; ½ unit. Prerequisite: Applied music on the 300 level and consent of instructor. APPLIED MUSIC STAFF.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

380. **Piano.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BRADLEY, FLETCHER, RICHARDS, SCHOONMAKER, STRAVINSKY, USRY, WATT, ZIRNER.
381. **Voice.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BOWEN, CLARK, FOOTE, HAMP, KELLOGG, MILLER, WILSON.
382. **Organ.** I, II; ½ or 1 unit. S; ¼ or ½ unit. MILES, PETTINGA.
383. **Violin.** I, II; ½ or 1 unit. S; ¼ or ½ unit. ROLLAND, SCHMITT.
384. **Viola.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GARVEY.
385. **Cello.** I, II; ½ or 1 unit. S; ¼ or ½ unit. FARRELL, SWENSON.
386. **String Bass.** I, II; ½ or 1 unit. S; ¼ or ½ unit. KROLICK.
387. **Flute.** I, II; ½ or 1 unit. S; ¼ or ½ unit. DELANEY.
388. **Clarinet.** I, II; ½ or 1 unit. S; ¼ or ½ unit. MCDOWELL.
389. **Oboe.** I, II; ½ or 1 unit. S; ¼ or ½ unit. LEDET.
390. **Bassoon.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BERRY.
391. **Cornet and Trumpet.** I, II; ½ or 1 unit. S; ¼ or ½ unit. SEXTON.
392. **French Horn.** I, II; ½ or 1 unit. S; ¼ or ½ unit. HOLDEN.
393. **Trombone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. STARR.
394. **Baritone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. STARR.
395. **Tuba.** I, II; ½ or 1 unit. S; ¼ or ½ unit. STARR.
396. **Percussion.** I, II; ½ or 1 unit. S; ¼ or ½ unit. PRICE.
397. **Harp.** I, II; ½ or 1 unit. S; ¼ or ½ unit.
398. **Saxophone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. COGGINS.
399. **Harpsichord.** I, II; ½ or 1 unit. S; ¼ or ½ unit. HUNTER.

PHILOSOPHY

The Department of philosophy offers graduate work leading to the Master of Arts and Doctor of Philosophy degrees.

Students undertaking graduate work with philosophy as their major subject must have had a grade-point average of at least 3.5 for that portion of the work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. In addition, students majoring in philosophy should have had a course in logic, a course in ethics, and a general course in the history of philosophy. Students with deficiencies are required to fill them by taking Philosophy 102 (or 333), 321, or 303-306, respectively, in addition to the minimum requirement of eight units for the master's degree.

Degree of Master of Arts. A candidate for this degree must choose at least one course in each of the following three fields: history of philosophy; theory of knowledge, including logic and philosophy of science; and theory of value, including ethics and esthetics. In addition to completing eight units of graduate

work, the candidate must take an oral examination on the work represented by these units. His adviser arranges and presides at this examination. Applications to have the thesis requirement waived are not approved except on recommendation of the adviser and vote of the department.

Degree of Doctor of Philosophy. A candidate for this degree will carry on (a) major studies in one of the three fields within the department; (b) minor studies amounting to at least two units in each of the two remaining fields; and (c) minor studies amounting to at least two units in a department other than philosophy. The three fields within the Department of Philosophy are history of philosophy; theory of knowledge, including logic and philosophy of science; and theory of value, including ethics, social philosophy, and esthetics. The candidate's choice of major and minors must be approved by the department.

The preliminary examination for the doctor's degree, in addition to the major and minor subjects, presupposes first-hand acquaintance with at least one major work of Plato, Aristotle, Augustine or Aquinas, Descartes, Spinoza, Leibniz, Locke, Berkeley, Hume, Kant, and Hegel.

The details of the special departmental requirements for graduate degrees can be obtained in mimeographed form by addressing a request to the Department of Philosophy, 119 Lincoln Hall.

ASSISTANTSHIPS

The department has available each year a limited number of half-time and quarter-time teaching assistantships for properly qualified graduate students. Applications should be sent directly to the department, not later than March 1 of the scholastic year preceding that for which application is made.

GRADUATE TEACHING FACULTY

Professors: D. W. Gotshalk (Chairman of Department), M. H. Fisch, J. A. Nicholson.
Associate Professors: B. J. Diggs, A. R. Turquette, F. L. Will.
Assistant Professors: O. A. Kubitz, L. Linsky, H. M. Tiebout.
Instructor: P. Diesing.

COURSES FOR GRADUATES

401. **Seminar in Ancient Philosophy.** I; 1 unit. Nicholson.
402. **Seminar in Ancient Philosophy.** II; 1 unit. Fisch.
403. **Seminar in Medieval Philosophy.** I or II; 1 unit. Diggs.
405. **Seventeenth Century Continental Thought (Descartes, Spinoza, Leibniz).** A study of the basic philosophical works of the three leading continental thinkers of the century. I or II; 1 unit. Gotshalk.
407. **British Empiricism.** I or II; 1 unit. Turquette.
408. **German Idealism (Kant).** I or II; 1 unit. Gotshalk.
409. **Recent American Philosophy.** Major American philosophers and movements since about 1900. I or II; 1 unit. Fisch.
411. **Recent Ethical Theory.** I or II; 1 unit. Diggs, Fisch.
413. **Logical Theory.** I or II; 1 unit. Prerequisite: A course in logic or consent of instructor. Turquette.
420. **Seminar in Semantics.** Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. I or II; 1 unit. Linsky.
421. **Seminar in Contemporary Problems.** Intensive study of selected problems on

topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. I or II; 1 unit. WILL.

422. **Seminar in Contemporary Problems.** Intensive study of selected problems on topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. I or II; 1 unit. FISCH, WILL.

423. **Seminar in Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. I; 1 unit. WILL.

424. **Seminar in Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. II; 1 unit. WILL.

430. **Seminar in Modern Aesthetics.** I or II; 1 unit. GOTSHALK.

493. **Research.** Research in special topics. I, II; ½ to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **History of Greek and Roman Philosophy.** I; ½ to 1 unit. FISCH.

304. **History of Medieval Philosophy.** Lectures and readings in the history of philosophy from St. Augustine to William of Ockham. II; ½ to 1 unit. DIGGS.

306. **History of Modern Philosophy.** II; ½ to 1 unit. GOTSHALK.

309. **The Philosophy of Plato.** I; ½ to 1 unit. NICHOLSON.

311. **Philosophical Ideas of the Nineteenth and Twentieth Centuries.** I, II; ½ to 1 unit. FISCH, TIEBOUT.

313. **American Philosophy.** The history of philosophy in America from colonial times to the present. I; ½ to 1 unit. FISCH.

317. **Great Books in Modern Thought.** Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. I; ½ to 1 unit. WILL.

319. **Philosophical Ideas in Latin America.** I; ½ to 1 unit. KUBITZ.

321. **Ethics and Value Theory.** I; ½ to 1 unit. DIGGS, FISCH.

323. **Philosophy of Art.** A discussion of the main philosophical principles of art and of outstanding contemporary philosophies of art. I; ½ to 1 unit. GOTSHALK.

324. **Philosophy of Religion.** II; ½ to 1 unit. NICHOLSON.

326. **Metaphysics.** II; ½ to 1 unit. LINSKY.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. I; ½ to 1 unit. TURQUETTE.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. II; ½ to 1 unit. WILL.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method, and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. I, II; ½ to 1 unit. LINSKY, WILL.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. I; ½ to 1 unit. TURQUETTE.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and complete-

ness. II; ½ to 1 unit. Prerequisite: Philosophy 333 or consent of instructor. TURQUETTE.

336. Philosophy of Law and of the State. II; ½ to 1 unit. DIESING.

337. Semantics. An investigation of semantical concepts such as denoting and truth. A study of the functions of language, definition, meaning and verification, semantical paradoxes. I; ½ to 1 unit. LINSKY.

340. Philosophy of Alfred North Whitehead. II; ½ to 1 unit. TIEBOUT.

350. Philosophy and Modern Life. II; ½ to 1 unit. GOTSHALK.

361. Comparative Religions: Religions of the East. I; ½ to 1 unit. TIEBOUT.

362. Comparative Religions: Religions of the West. II; ½ to 1 unit. TIEBOUT.

PHYSICAL EDUCATION

(Including Health Education and Recreation)

The department offers graduate study programs in three areas — Physical Education, Health Education, and Recreation.

GRADUATE TEACHING FACULTY

Professors: S. C. STALEY (Director of School of Physical Education), C. K. BRIGHTBILL, T. K. CURETON, H. S. HOYMAN, LAURA J. HUELSTER, C. O. JACKSON, G. T. STAFFORD.

Associate Professors: F. E. BOYS, A. E. FLORIO, A. W. HUBBARD, R. H. JOHNSON, C. G. KNAPP, A. V. SAPORA.

Assistant Professor: ANNE E. JEWETT.

ASSISTANTSHIPS

A limited number of part-time teaching assistantships and part-time research assistantships are available in physical education, health education, and recreation. These appointments are made annually and are open to candidates for advanced degrees. Candidates for these positions must have a 4.0 grade average for the last two years of undergraduate study.

Physical Education

The department offers programs of graduate study leading to the degrees of Master of Science and Doctor of Philosophy in Physical Education. Both programs are centered in training teachers, administrators, and research workers in the general field of physical education, but also offer opportunities for training in the related fields of health education and recreation and the special fields of sports, dance, and exercise.

Admission requirements for a major in this field are (a) a minimum grade-point average of 3.5 (half way between B and C) for that portion of the work which represents the last fifty per cent of the hours earned for the bachelor's degree; (b) thirty hours of approved undergraduate credit in physical education or related fields; (c) eighteen hours of approved undergraduate credit in science; (d) sixteen hours of undergraduate credit in education; and (e) a course in statistics or measurement. Students are not admitted on limited status.

Admission requirements for a minor in the department are twenty hours of physical education. Students who do not meet this requirement, however, may be admitted to certain courses, if approved by the instructor.

Degree of Master of Science. Graduation requirements for this degree are eight units (equivalent of thirty-two hours credit) to include (a) four units of credit in physical education or related (health education or recreation) courses;

(b) two units of credit in education including two of the following one-half unit courses: Education 301, 302, 303, 304; and the following one-half unit courses: Education 311 and 312; (c) registration in and satisfactory completion of Physical Education 490 for one semester, without credit; (d) presentation of an acceptable thesis, two units.

Candidates may petition to waive the thesis and seminar requirements. Those who are excused are required to secure two units' credit in lieu of thesis credit (item d) and in addition are required to take and pass a final comprehensive written examination in physical education and related fields.

Degree of Doctor of Philosophy. Graduation requirements for this degree are twenty-four units of graduate credit (equivalent of ninety-six hours of credit) including (a) a minimum of eight units of credit in physical education courses or related courses in health education or recreation; (b) one minor for a minimum of four units, or two minors for a minimum of two units each; (c) registration in and satisfactory completion of Physical Education 490; and (d) presentation of an acceptable thesis for approximately eight units.

Each candidate must pass a reading examination in French and German. No student will be considered as beginning his second year of graduate work until he has passed one of these examinations. Both examinations must be passed before taking the preliminary examination.

Each candidate must pass a written examination covering his major field of study and an oral examination covering his major and minor fields of study. This preliminary examination will be given toward the end of the second year of study, or by special permission, at the beginning of the third year (not later than November 1).

Each candidate must pass a final examination, principally on his thesis. This examination must be taken at least two weeks before the degree is to be conferred.

Anyone wanting additional information about these programs should write to S. C. Staley, 108 Huff Gymnasium, University of Illinois, Champaign, Illinois.

COURSES FOR GRADUATES

(Open to both men and women)

401. **Problems in Physical Education.** Organization and conduct of curricula in physical education; physiological, social, and psychological implications; selection and distribution of activities; facilities and equipment; teacher preparations; professional advancement; literature; research problems. I or II; 1 unit. Huelster, Jackson, Johnson.

406. **Philosophy of Sport.** Reviews the history of sport; cultural, social, hygienic, educational, character, personality, therapeutic, and military implications; organization of sports programs; literature; research programs. I or II; 1 unit. Brightbill, Jackson, Johnson.

407. **Sports Psychology.** Processes by which patterns of behavior important in physical education and sports are formed; interpretation of participant behavior in sports; literature; research problems. I or II; 1 unit. Prerequisite: Psychology 100; Education 409; consent of instructor. Hubbard.

450. **Trends and Techniques in Rehabilitation.** Philosophy of rehabilitation; problems in the education of the handicapped (blind and partially sighted, deaf and hard of hearing, mentally handicapped, socially maladjusted, cripple, cardiac, epileptic, speech deviate, etc.); state and federal plans for education and vocational training of handicapped children and adults. I or II; 1 unit. Stafford.

451. **Scientific Foundations of Physical Fitness.** Scientific basis of programs in physical fitness; programs of governmental and private organizations; analysis of physical fitness tests; techniques used in physical fitness testing and

remedial clinics. I or II; 1 unit. Prerequisite: Undergraduate anatomy, physiology, measurement, or statistics. CURETON.

452. **Scientific Analysis of Physical Education Activities.** Analysis of a selected number of physical education activities by the application of principles and methods of advanced physiology of exercise, mechanics, and kinesiology. I or II; 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry. CURETON.

453. **Anthropometrical and Body Mechanics Research Techniques.** Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of procedures used in existing research studies; laboratory and computational projects in biophysical aspects. I or II; 1 unit. CURETON.

490. **Seminar.** Lectures, discussions, and critiques on physical education, kinesitherapy, recreation, sports, camping, outdoor education, and related subjects by faculty members and visiting professional leaders. Presentation of theses by students. I, II; no credit. STAFF.

491. **Thesis.** Open only to students engaged in preparing theses. Amount of credit is adapted to each individual's case. I, II; ½ to 4 units. STAFF.

493. **Research.** Independent research in special projects. Open only to students working toward doctor's degree. I, II; ½ to 2 units. STAFF.

495. **Techniques of Research in Health, Physical Education, and Recreation.** Review and appraisal of the more common research procedures and literature in the fields of physical education, health, safety, kinesitherapy, recreation, sports, camping, and outdoor education; application of statistical procedures, library methods, survey procedures, evaluation procedures, and experimental methods. I, II; 1 unit. CURETON, HUBBARD.

Health Education

The Department of Physical Education also offers a program of graduate study leading to the degree of Master of Science in Health Education. This program is centered in training teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for training in the special fields of public health education, safety education, and kinesitherapy.

Admission requirements for a major in this field are (a) a minimum grade-point average of 3.5 for all courses taken during the last two years of undergraduate study; (b) thirty semester hours of approved undergraduate credit in health education or closely related courses; (c) twenty-four semester hours of approved undergraduate credit in science; (d) sixteen semester hours of credit in education; and (e) a course in statistics or measurement. Students are not admitted on limited status.

Graduation requirements for this degree are eight units (equivalent of thirty-two semester hours credit) to include (a) four units in health education or approved courses in physical education; (b) two units in education, including two of the following one-half unit courses: Education 301, 302, 303, 304; and the following one-half unit courses: Education 311 and 312; (c) registration in and satisfactory completion of Health Education 490, without credit; (d) presentation of an acceptable thesis in health education, two units. (The thesis requirement may be waived on petition, in which case two additional units of approved credit are required.) A final comprehensive written examination in health education may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

Anyone wanting additional information regarding this program should write to H. S. Hoyman, 114 Huff Gymnasium, University of Illinois, Champaign, Illinois.

COURSES FOR GRADUATES

(Open to both men and women)

400. **Scientific Foundations of Health Education.** Designed to reinforce and extend the graduate student's knowledge of pertinent scientific health facts and principles, as these apply to the further improvement of personal, family, and community health. I or II; 1 unit. HOYMAN, STAFFORD.

401. **Problems in School Health Education.** Deals primarily with the history, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. I or II; 1 unit. HOYMAN, JACKSON, STAFFORD.

402. **Problems in Safety Education.** Philosophy of safety; traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. I or II; 1 unit. FLORIO, STAFFORD.

403. **Problems in Public Health.** Deals with the basic facts and principles of public health at the local, state, and national levels; including the relationships between public health departments, voluntary health agencies, and the schools. I or II; 1 unit. HOYMAN.

404. **Trends and Issues in Sex Education.** A critical analysis of current trends and basic issues of social hygiene. Study of present status of social hygiene in the United States and selected foreign countries. A critical analysis of the philosophy, principles, methods, and current problems of social hygiene in Illinois and the United States. I or II; 1 unit. HOYMAN.

490. **Seminar.** Student presentation of thesis reports in health and safety education. Informal discussions, lectures, and critical analysis of current problems in health and safety education. I or II; no credit. STAFF.

491. **Thesis.** Preparation of theses in health education, safety education, and kinesitherapy. I, II; ½ to 2 units. STAFF.

492. **Research.** Independent research in special projects. Open only to students working toward doctor's degree. I, II; ½ to 2 units. STAFF.

Recreation

The Department of Physical Education also offers a program of graduate study leading to the degree of Master of Science in Recreation. This program is centered in training leaders, supervisors, administrators, teachers, and research workers in community recreation, but also offers opportunities for training in the related fields of industrial and institutional recreation and specialization in given program areas of recreation such as sports, music, dramatics, arts and crafts, camping and outdoor education, and the like.

Admission requirements for a major in this field are (a) a minimum grade-point average of 3.5 (half way between B and C) for all courses taken during the last two years in earning the bachelor's degree; (b) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (c) fifteen semester hours in the social and psychological sciences; (d) eight semester hours of undergraduate credit in the natural sciences; and (e) a course in statistics or tests and measurements. Applicants lacking a portion of the prerequisites under item (b) may substitute certified professional field experience, not to exceed eight semester hours. Students are not admitted on limited status.

Graduation requirements for this degree are eight units (equivalent of thirty-two semester hours credit) to include (a) four units of credit in approved courses to be chosen in the following areas: recreation, education, political science,

psychology, social work, and sociology; (b) two units of approved electives to be chosen in the following areas: art, botany, geology, health education, landscape architecture, literature, music, physical education, speech, and zoology; (c) registration in and satisfactory completion of Recreation 490, without credit; (d) presentation of an acceptable thesis in recreation, two units.

The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in recreation may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

Anyone wanting additional information regarding this program should write to Charles K. Brightbill, 111 Huff Gymnasium, University of Illinois, Champaign, Illinois.

COURSES FOR GRADUATES

(Open to both men and women)

401. **Foundations of Recreation.** Basic philosophical, historical, and scientific foundations of leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. I; 1 unit. Prerequisite: Undergraduate principles of recreation, or equivalent. Brightbill.

402. **Recreation Administration.** Administration of recreation programs and services provided by municipal, county, state, and national departments and private agencies in terms of the general well-being of individuals, families, and communities. II; 1 unit. Prerequisite: Undergraduate organization of recreation, or equivalent. Brightbill.

403. **Evaluation of Recreation Resources and Programs.** Includes the methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals, evaluating and appraising community recreation programs and services; and research in the field of recreation. I; 1 unit. Prerequisite: Undergraduate principles of recreation or equivalent. Sapora.

404. **Outdoor Education and Recreation.** Includes the philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. Prerequisite: Camp counseling, or equivalent, and one undergraduate course in biology, botany, geology, or zoology. II; 1 unit. Randall.

490. **Seminar.** Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. I, II; no credit. Staff.

491. **Thesis.** Open only to students engaged in preparing recreation theses. I, II; ½ to 2 units. Staff.

PHYSICAL SCIENCES

A special program leading to the degree of Master of Science in the Physical Sciences is available to meet the needs of students who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has

emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit will carry credit toward the degree. To qualify for the degree, a student must have had, or must include in his program, at least one course in mathematics beyond the calculus, and for which the calculus is prerequisite.

Candidates for the degree of Master of Science in the Teaching of the Physical Sciences must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in the physical sciences and the electives must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 4.0 for that portion of work which represents the last fifty per cent of the hours earned for the bachelor's degree, exclusive of required courses in physical education and military training. Students on limited status will not be admitted. The adviser for candidates for this degree is Professor J. C. Bailar, Jr., 107 Chemistry Annex.

PHYSICO-CHEMICAL BIOLOGY

Training for the degree of Doctor of Philosophy in Physico-Chemical Biology is administered by a committee of the Division of Biological Sciences. The chairman of this committee is Professor Robert Emerson, 155 Natural History Building. The purpose of this curriculum is to offer students who wish to prepare for a career in biological research, a training which combines courses in physics and chemistry with study of the fundamentals of biology as illustrated by some natural group of organisms. The majority of biological work will ordinarily be in one of the biological departments (Bacteriology, Botany, Entomology, Physiology, Zoology), but may be divided among these fields to suit the needs of the candidate.

Research facilities are available in cellular physiology, microbiology, photosynthesis, electrophysiology, diffusion processes, and radiobiology.

Applicants for admission must have a grade-point average of at least 4.0 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Under exceptional circumstances, a student with a lower grade-point average may be admitted on limited status.

Minimum admission requirements are college biology (six hours), college physics (eight hours), analytical and organic chemistry, and calculus. Deficiencies in any of these requirements may be made up during the first year of graduate study, but no graduate credit will be given. A total of six hours of calculus will be needed as prerequisite for the physics requirement listed below.

All candidates are required to take the following courses, or show equivalent credits:

Chemistry: Chemistry 240 (Physical Chemistry), and either 350 (Biochemistry) or 336 and 337 (Organic Chemistry).

Physics: Two units from Physics 341, 342 (Electricity); 270, 371, 372, 373, 374 (Light); 360 (Heat); 281, 381 (Atomic Physics); 362 (Nuclear Physics).

Cytology or Genetics: One unit from Zoology 403 (Cytology), 455 (Physiological Genetics), 351 and 352 (Genetics); Botany 320 or 322 (Genetics), 420 (Cytogenetics); Bacteriology 405 (Microbiological Genetics).

Physiology: One unit from Physiology 306 or 307 (Mammalian Physiology);

361 (Comparative Physiology); 362 (Cellular Physiology); Botany 333 or 335, or 433 (Plant Physiology); or Entomology 324 or 325 (Insect Physiology).

Advanced Biology: Two units from the following: Zoology 333 (Embryology), 320 (Invertebrate Zoology), 318 (Protozoology), 334 (Histology), 332 (Advanced Vertebrate Anatomy); Botany 304 (General Morphology), 345 (Plant Anatomy), 322 (Heredity and Evolution), 372 (Mycology), 402 (Physiological Genetics), 472 (Industrial Molds and Fermentations), 340 (Histology, Microtechnique); Bacteriology 300 (General Bacteriology); Entomology 322 (Insect Bionomics) or 407 (Insect Anatomy); Bacteriology 306 (Principles of Experimental Biology); Bacteriology 351 (Viruses).

Eight additional units are to be chosen from selected areas of biology, physics, chemistry, or mathematics.

All students in the curriculum are expected to take Biological Sciences 331, 332, and 333 (Radiobiology, Photobiology, and Electrobiology), and Physiology 462 (Advanced General Physiology).

Other courses suitable to supplement the curriculum are Bacteriology 404 (Analysis of Bacteriological Procedures), 420 (Chemistry of Microbic Processes); 451 (Experimental Virology); 425 (Bacterial Metabolism Laboratory); Zoology 404 (Experimental Cytology); 467 (Experimental Embryology); Botany 419 (Photosynthesis and Related Subjects).

If some of the above requirements have already been fulfilled by undergraduate work, the student must submit for approval of the committee additional work of equivalent credit in the same or other field.

After completion of a minimum of sixteen units of graduate work, a written preliminary examination will be required. This will be followed by an oral examination given by a committee appointed by the Dean of the Graduate College. For students transferring from other universities, at least one semester of graduate work at the University of Illinois will be required before admission to the preliminary examination.

Subject to approval by the committee, candidates for the degree of Doctor of Philosophy in other fields may take a minor in physico-chemical biology.

FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships are available in physico-chemical biology. Applications for fellowships should be made on forms provided by the Graduate College and should be forwarded to the Dean of the Graduate College.

No teaching assistantships are available in physico-chemical biology, because the curriculum is interdepartmental in character. Applications for teaching assistantships should be sent to the head of the department in which the candidate would like to have teaching experience.

A few research assistantships are available by arrangement with staff members who have special research projects.

PHYSICS

The Department of Physics offers graduate work leading to the Master of Science and Doctor of Philosophy degrees.

There is opportunity for specialization in nuclear physics, including research with the betatrons, the cyclotron, and with radioactive sources; in nuclear magnetic resonance; in cosmic rays; in theoretical physics; in the physics of solids, including research on metals, semi-conductors and cryogenics; and, to a limited extent, in biophysics.

The requirements for admission to the Graduate College with a major in physics are twenty semester hours in physics, including Physics 321, 341, and 342

or the equivalent, and excluding courses in general physics and others numbered below 270; a grade average of at least 3.75 for that portion of the work which represents the last fifty per cent of the hours completed for the bachelor's degree, exclusive of required courses in physical education and military training. Students on limited status will not be admitted.

Students who lack some of the prerequisite courses may be admitted but will be required to take the prerequisite courses without graduate credit.

Students admitted to the Graduate College with a major in another department may, with the consent of their adviser, elect a minor in physics provided they satisfy the prerequisites for the physics courses they elect.

The requirements for the Master of Science degree in physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the degree of Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the Head of the Department. This pamphlet also contains fuller descriptions of the courses in physics and related courses in mathematics and suggests appropriate course sequences.

Candidates for the degree of Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Education 311, 312, and one additional unit in education selected from Education 301, 302, 303, and 304. Students applying for admission must have the same grade-point average as that required by the department. Those on limited status will not be admitted to this program. The adviser for candidates for this degree is Professor R. F. Paton, 206 Physics Laboratory.

FELLOWSHIPS AND ASSISTANTSHIPS

The Graduate College offers fellowships for which students in physics are eligible, and in addition the Physics Department has a few industrial fellowships. The latter are usually awarded to students who have been in the University for two or more semesters. Applications for either University or industrial fellowships should be addressed to the Dean of the Graduate College.

The department employs a number of half-time graduate teaching and research assistants. Research assistants are expected to be advanced graduate students or to have technical experience of value to the research programs of the department. Inquiries about and applications for these positions should be addressed to the Head of the Department.

GRADUATE TEACHING FACULTY

Professors: F. W. Loomis (Head of Department), G. M. Almy, J. Bardeen, J. H. Bartlett, G. Bernardini, A. O. Hanson, D. W. Kerst, J. S. Koehler, P. G. Kruger, A. Longacre, E. M. Lyman, R. J. Maurer, R. E. Meagher, A. T. Nordsieck, F. Seitz, C. W. Sherwin.

Associate Professors: J. S. Allen, R. A. Becker, G. F. Chew, R. B. Duffield, R. D. Hill, R. I. Hulsizer, R. F. Paton, C. S. Robinson.

Assistant Professors: G. Ascoli, P. Axel, H. Frauenfelder, W. K. Jentschke, L. S. Lavatelli, D. Lazarus, F. Low, D. E. Mapother, R. D. Rawcliffe, C. P. Slichter, J. H. Smith, J. N. Snyder.

Associate: L. J. Koester.

COURSES FOR GRADUATES

400. **Problems and Methods of Theoretical Physics.** Vector analysis. Boundary value problems. The equations of mathematical physics; variational deriva-

tion; contour integration; ordinary differential equations; boundary conditions; Green's functions; Eigen-functions; Laplace's and Poisson's equations in one, two, and three dimensions; conformal mapping; integral representation; asymptotic expansions. I; 1 unit. Prerequisite: Mathematics 342, 345, 347, or 387; Physics 322 and 342, or consent of instructor. BARTLETT.

403. **Experimental Research Techniques.** This course is intended to bridge the gap between the undergraduate laboratory work and actual research and experimental physics. The student is introduced to the elements of glass-blowing and machine shop practice. There are experiments on the production and measurement of high vacuums, the detection of single particles, the measurement of small currents, x-rays, nuclear induction, and a number of other problems in nuclear and atomic physics including nuclear spectroscopy and mass spectroscopy. The student has wide latitude in selecting the experiments and techniques which interest him. I, II; 1 unit. Prerequisite: Physics 343 and 374; consent of instructor. FRAUENFELDER.

404. **Experimental Research Techniques.** Continuation of Physics 403. The student usually selects a more advanced research project which he pursues for most of the semester. I, II; 1 unit. Prerequisite: Physics 403. FRAUENFELDER.

422. **Dynamics.** LaGrange equations, small vibrations; Hamilton's canonical equations; Hamilton's principle, least action; contact transformations; Hamilton-Jacobi equation; perturbation theory; non-linear mechanics. II; 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. **Relativity and Cosmology.** Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. MCVITTIE.

435. **Conduction of Electricity in Solids.** Same as Electrical Engineering 435. Application of quantum theory of solids to conduction of electricity in metals, insulators, and semi-conductors. Emphasis is placed on fundamentals of current flow in semi-conductors to provide a background for transistor electronics. Topics covered include impurity and intrinsic semi-conductors, photoconductivity, Hall and thermoelectric effects, theory of conductivity in solids, metal semi-conductors rectifying contacts, p-n junctions, theory and characteristics of point-contact and junction transistors. II; 1 unit. Prerequisite: Physics 381, Electrical Engineering 425, or consent of instructor. BARDEEN.

441. **Electrodynamics.** Electrostatics; Poisson's equations, Laplace's equation; boundary value problems; spherical harmonics; multipole potentials. Dielectrics; microscopic and macroscopic fields; susceptibility. Magneto-statics: vector potential, magnetic multipoles. Magnetic media: ferro-, dia-, paramagnetism. Conducting media. Maxwell's equations: field energy and momentum; retarded potentials. Fields due to moving charges: Lienard-Wiechert potential; fields of an accelerated charge. I; 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor. NORDSIECK.

442. **Electrodynamics.** Continuation of Physics 441. Self force of a finite electron. Multipole radiation. Propagation of radiation in material media: wave guides; modes of propagation; skin effect. Special relativity. Lorentz-Abraham electron. II; 1 unit. Prerequisite: Physics 441. NORDSIECK.

463. **Statistical Mechanics.** Statistical ensembles; the Maxwell-Boltzmann law; approach to equilibrium; quantum statistical mechanics; application of sta-

tistical mechanics to thermodynamic processes. I; 1 unit. Prerequisite: Physics 422; Physics 360 or 362. Low.

481. **Line Spectra and Atomic Structure.** A lecture course presenting Planck's law of radiation, the Bohr theory, de Broglie waves, and a brief introduction to wave mechanics. The course deals with the atomic nature of matter, elementary particles, the photo-electric effect, simple and complex atomic spectra, x-ray spectra, hyperfine structure, absorption, fluorescence and ionization. I; 1 unit. Prerequisite: Physics 322, 342, and 372. Slichter.

482. **Introduction to Quantum Mechanics.** Schrödinger equation, stationary states; hydrogen atom; perturbation theory; electron spin; the exclusion principle; many electron atoms; interatomic forces and molecular structure. Recommended primarily to students of the physical sciences other than physics who desire an introductory course in the aspects of quantum mechanics which are basic to a modern understanding of atoms, molecules, solids, elementary atomic processes and chemical reactions. I; 1 unit. Prerequisite: Physics 381, Mathematics 345 or equivalent, or consent of instructor. Low.

483. **Nuclear Physics.** Detection of nuclear radiations; radioactive decay, natural radioactive isotopes, abundance of stable elements and stable isotopes; Rutherford scattering, interaction of nuclear radiations (excluding neutrons) with matter, nuclear transformations, nuclear masses. I; 1 unit. Prerequisite: Physics 481. Hanson.

484. **Nuclear Physics.** Excited states of nuclei, fast and slow neutrons, magnetic moments of nuclei, nuclear forces, artificially produced radioactive isotopes, theory of beta decay, resonance reactions, Bohr's drop model, fission. II; 1 unit. Prerequisite: Physics 483. Hanson.

485. **Quantum Mechanics.** Schrödinger wave equation; stationary state solutions. Operators and matrices. Perturbation theory; non-degenerate and degenerate cases. WKB approximation; non-harmonic oscillator, etc. Collision problems; Born approximation; method of partial waves. I; 1 unit. Prerequisite: Physics 481 and 422; Physics 400 or consent of instructor. Snyder.

486. **Quantum Mechanics.** Time dependent perturbation theory; elastic and inelastic scattering, absorption of light. Wave functions for identical particles, quantum statistics. Pauli spin operator. Classification of atomic states. Thomas-Fermi model. Quantization of radiation field. Interaction of light with matter. Dirac electron theory. II; 1 unit. Prerequisite: Physics 485. Snyder.

487. **Advanced Quantum Mechanics.** Second quantization. Fields of spin 0, ½, 1. Beta decay theory. Meson theory of nuclear forces. I, II; 1 unit. Prerequisite: Physics 486.

488. **Theoretical Nuclear Physics.** Quantum theory of nuclear structure and nuclear transformations. I, II; 1 unit. Prerequisite: Physics 485. Chew.

489. **Theory of Solids.** This course reviews the introductory phases of the modern theory of crystalline materials. Topics treated include the classical theory of ionic crystals, specific heats, electron theory of metals and semi-conductors, the band approximation. I; 1 unit. Prerequisite: Physics 360, 362, 381, or consent of instructor. Koehler.

490. **Theory of Solids.** Continuation of Physics 489. The electronic structure of solids, optical and magnetic properties, crystal lattice imperfections, diffusion and ionic conductivity, cooperative phenomena, superconductivity. II; 1 unit. Prerequisite: Physics 489 or consent of instructor. Koehler.

491. **Cosmic Rays.** A lecture course dealing with the interactions among particles, nuclei and radiation at high energies, and the interpretation of cosmic

ray phenomena in terms of such interactions. I; 1 unit. Prerequisite: Physics 281, 342, or consent of instructor. HULSIZER.

493. **Research.** I, II; 1 to 4 units each semester.

498. **Seminar.** A course number occasionally used when it is desirable to give credit for individual but supervised study of a subject not covered by regular courses. Formal seminar courses are sometimes given under this number though most of the seminars in the department are organized informally and without credit. I, II; 1 to 2 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. **Theoretical Mechanics.** Lectures and problems. Physics 321 and 322 are fundamental to many advanced courses, and should be elected as early as possible by those intending to specialize in physics. Laws of motion, vectors, statics, energy and momentum principles for a particle and for systems of particles, motion of a particle under constant forces, plane motion of a rigid body, simple harmonic motion and resonance, impact. I, II; 1 unit, except to graduate physics majors. Prerequisite: General physics and calculus. SMITH.

322. **Theoretical Mechanics.** Continuation of Physics 321. Motion of a particle under a variable force, central field motion, accelerated reference systems, motion of a particle subject to constraints, rotation of a rigid body in three dimensions, vibrating systems and normal coordinates, generalized coordinates. I, II; 1 unit. Prerequisite: Physics 321. BECKER.

330. **Sound.** Lectures and problems. Fundamentals of wave motion as related to sound and vibration; origin, propagation, interference, refraction, and diffraction of sound; vibration of strings and air columns. Some applications of sound theory; musical instruments, loud speakers, signalling and detecting devices. Study of speech and hearing. II; 1 unit. Prerequisite: General physics and calculus. BECKER.

341. **Electricity and Magnetism.** Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. Fundamental laws logically developed and summarized in Maxwell's equations; forces and energies associated with electric and magnetic properties of matter; generation and propagation of electromagnetic waves. I; 1 unit, except to graduate physics majors. Prerequisite: General physics and calculus; registration in Mathematics 341 or 343, or consent of instructor. LYMAN.

342. **Electricity and Magnetism.** Continuation of Physics 341. Boundary conditions and special methods in boundary value problems; interpretation of dielectric and magnetic properties of matter from the point of view of atomic and crystalline properties; use of complex notation in circuit problems; coupled circuits; non-linear circuits, transmission lines; radiation from antennas; transmission and reflection of electromagnetic waves. II; 1 unit, except to graduate physics majors. Prerequisite: Physics 341. LYMAN.

343. **Vacuum Tube Circuits.** Lectures, problems, and laboratory. The physics of vacuum tubes, rectifiers, and cathode-ray tubes and associated circuits; elementary theory and applications of vacuum tubes as linear circuit elements in amplifiers and electronic instruments. Emphasis on experimental techniques. II; 1 unit. Prerequisite: Physics 341. ALLEN.

344. **Vacuum Tube Circuits.** Continuation of Physics 343. Electronic instruments and techniques used in research in physics; advanced theory and experiments emphasizing the use of vacuum tubes as non-linear circuit elements, e.g., multivibrators, blocking oscillators, pulse generators and amplifiers, Geiger

counter circuits, synchronizing and time-measuring circuits. Familiarization with instruments and techniques used in research in physics. I; 1 unit. Prerequisite: Physics 343 or equivalent. ALLEN.

351. **Biophysics.** Lectures and recitations. The nature of living systems: cells, chromosomes, and the reproductive cycle; effects of penetrating radiation; transport processes: diffusion, electrolytic migration, permeability of living membranes (users of tracers), electrode phenomena, osmosis and growth. I; 1 unit. Prerequisite: General physics and calculus, or consent of instructor. BARTLETT.

354. **Biophysics Laboratory.** Same as Biological Sciences 354. Laboratory experiments in optics, electricity, and nuclear physics designed to familiarize the student with the physical apparatus and techniques useful in biophysics. II; 1 unit. Prerequisite: General physics, calculus, and one unit of advanced physics, or consent of instructor. RAWCLIFFE.

360. **Heat and Thermodynamics.** Lectures and problems. Definition and measurement of thermodynamic functions such as temperature, entropy, enthalpy, etc.; heat conversion and transfer; equilibrium and cyclic phenomena; thermal radiation; energy exchanges at very low and very high temperatures. I, II; 1 unit (one-half unit for students who have credit for Physics 260). Prerequisite: General physics and calculus. MAPOTHER.

362. **Kinetic Theory and Statistics.** A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and applications. I, II; 1 unit. Prerequisite: Physics 360 or consent of instructor. MAPOTHER.

371. **Light.** Lectures, problems, and laboratory. Geometrical optics: image formation, thick lens theory, aberrations, photometry of optical systems, optical instruments. Wave optics: interference and diffraction. I; 1 unit. Prerequisite: General physics and calculus. ALMY, RAWCLIFFE.

372. **Light.** Continuation of Physics 371. Electromagnetic character of light, Maxwell's equations, theory of reflection and refraction, polarization, double refraction, crystal optics, dispersion, scattering, optical properties of metals. II; ½ unit. Prerequisite: Physics 371. ALMY, RAWCLIFFE.

374. **Light Laboratory.** To accompany Physics 372, and continue laboratory work of Physics 371. Experiments in interferometry, diffraction, polarization, photographic processes, and spectroscopy. II; ½ unit. Prerequisite: Registration in Physics 372 or consent of instructor. RAWCLIFFE.

381. **Atomic Physics.** A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms and molecules. The topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure and an introduction to the ideas of quantum mechanics. I; 1 unit. Prerequisite: General physics and calculus. BARDEEN.

382. **Radioactivity and Nuclear Physics.** A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, and the application of nuclear phenomena to some practical problems. II; 1 unit. Prerequisite: Physics 381. BARDEEN.

PHYSIOLOGY

The Department of Physiology offers graduate study leading to the degrees of Master of Science and Doctor of Philosophy.

To become a candidate for the degree of Master of Science, the student must meet the requirements of the Graduate College. The department has no requirement concerning specific undergraduate major or minor fields, but does require that the student shall have taken as an undergraduate those courses which are prerequisite for the advanced courses ordinarily taken by candidates for the master's degree. That is, the candidate should have passed, as an undergraduate, the equivalent of fifteen hours of animal biology and twenty hours of chemistry. At the discretion of the Department's Graduate Committee, a candidate may be admitted on limited status, provided that he has passed all the courses required in the premedical curriculum.

To obtain the degree of Master of Science, the candidate must meet the general requirements of the Graduate College concerning grades, residence, and thesis. In addition the department requires that he take at least four units of course work in physiology, at least two units outside the department, and two units of research. Before the degree is granted, the candidate must pass a departmental general examination. At the discretion of the department, two units of approved course work may be substituted for the research and thesis but this will be done only rarely.

Permission to study toward the doctorate must be secured from the Graduate College and from the Department's Graduate Committee. The candidate must have passed the course work for a master's degree in physiology, or its equivalent, and must have on file in the department office transcripts of his undergraduate and graduate record. Factors considered are (1) grades; (2) results of the Graduate Record Examination, which the student is urged to take at the earliest opportunity; (3) the recommendation of his potential major adviser; and (4) at the discretion of the Graduate Committee, a qualifying examination administered by the department.

To obtain the degree of Doctor of Philosophy the candidate must comply with the general regulations of the Graduate College concerning grades, units of work, foreign languages, residence, thesis, preliminary examination, and final examination. The department requires in addition that he pass a written, qualifying comprehensive examination in physiology before he is permitted to take his preliminary examination.

All candidates for the doctorate are urged to obtain as early as possible in their careers an adequate background at the undergraduate level in general zoology; comparative vertebrate anatomy; general botany; general bacteriology; general, inorganic, qualitative, quantitative, organic, and physical chemistry; general physics; analytic geometry, calculus, and elementary statistics. Among graduate courses that must be taken are advanced mammalian physiology, comparative physiology, cellular physiology, neurophysiology, endocrinology, vertebrate embryology, genetics, vertebrate histology, and biochemistry. To complete the course work for the doctorate, graduate courses, of which a significant number shall be of the four hundred series, may be taken in the following fields: physiology, zoology, entomology, bacteriology, botany, physico-chemical biology, physics, chemistry, animal nutrition, animal science, psychology, mathematics, and other appropriate areas.

Eight to eleven units of research for the thesis are required, and may be conducted in one of several areas: cellular physiology, comparative physiology, mammalian physiology, electrophysiology, neurophysiology, radiobiology, endocrinology, environmental and stress physiology.

For a sole minor, candidates from other departments must offer four units in

physiology and, in addition, one semester of seminar. For a first minor, three units are required and one semester of seminar is recommended. For a second minor, two units are required.

ASSISTANTSHIPS

Each year the department appoints a number of graduate teaching and research assistants, with stipends set by the general regulations of the University. Inquiries concerning assistantships should be directed to the departmental office, 401 Natural History Building.

GRADUATE TEACHING FACULTY

Professors: R. E. Johnson (Head of Department), C. L. Prosser, F. R. Steggerda.
Associate Professors: H. Quastler, A. B. Taylor.
Assistant Professors: J. D. Anderson, F. Sargent, II, S. G. Stolpe.
Instructor: W. H. Johnson.

COURSES FOR GRADUATES

401. **Mammalian Physiology Seminar.** Current trends in mammalian physiology. I or II; ½ unit. Prerequisite: Two semesters of mammalian physiology or equivalent; consent of instructor. Steggerda.

403. **Experimental Mammalian Physiology, I.** The physiological applications of experimental mammalian surgery. I, II; 1 unit. Prerequisite: Two semesters of advanced mammalian physiology, or equivalent; consent of instructor. Steggerda.

404. **Experimental Mammalian Physiology, II.** The physiological applications of experimental pharmacodynamics. I or II; 1 unit. Prerequisite: Physiology 306 and 307, or equivalent; consent of instructor. Steggerda.

416. **Structure and Function of the Nervous System.** The understanding of nervous function through the experimental approach. II; 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. W. H. Johnson.

421. **Gross Human Anatomy.** A general survey of the structures of the human body, with emphasis on the relations between form and function. I or II; 1 unit. Prerequisite: One semester of embryology; consent of instructor. Elhardt.

441. **Bioclimatology.** Same as Geography 441. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes of mammals, and the application of meteorological, climatological, and geographical techniques in physiological studies. I or II; ½ unit. Prerequisite: Consent of instructor. Page, Sargent.

454. **Regulative Mechanisms in Behavior.** Seminar on the physiological aspects of regulative mechanisms and their mutual interactions. I or II; ½ unit. Prerequisite: One year of advanced physiology; consent of instructor. R. E. Johnson.

463. **Advanced General Physiology.** Same as Zoology 462. Seminar, lectures, student reports, discussions. I or II; ½ unit. Prerequisite: Consent of instructor. Prosser.

472. **Advanced Cellular Physiology.** Same as Biological Science 472. Architecture and dynamics of living material: molecular and microstructure of cells, cellular metabolism and energetics, enzyme kinetics, active transport, cellular movement, bioelectricity, effects of radiation, duplication. II; 1¼ units.

Credit not allowed for both Physiology 362 and 472. Prerequisite: Physical chemistry and calculus. PROSSER.

481. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. Not more than one unit in Physiology 481 may be offered toward a master's degree. I, II; ½ to 1 unit. Prerequisite: Approval of department. STAFF.

491. **Research.** I; ½ to 4 units. STAFF.

492. **Research.** II; ½ to 4 units. STAFF.

Research may be conducted in the following areas, with the consent of the instructor:

Cellular Physiology. ANDERSON, PROSSER, TAYLOR.

Comparative Physiology. PROSSER.

Mammalian Physiology. STEGGERDA.

Electrophysiology and Biophysics. W. H. JOHNSON, PROSSER.

Radiobiology. QUASTLER.

Endocrinology. STOLPE.

Environmental and Stress Physiology. R. E. JOHNSON, SARGENT, STEGGERDA.

Bioclimatology. SARGENT.

Neurophysiology. W. H. JOHNSON.

Human Physiological Anatomy. ELHARDT.

Functional Microanatomy. TAYLOR.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Advanced Mammalian Physiology.** The significance of muscle, nerve, blood, and circulation in mammalian physiology. I; 1 unit. Prerequisite: Courses totaling twenty hours in chemistry, animal biology, or both, beyond the introductory freshman courses; consent of instructor. STEGGERDA.

307. **Advanced Mammalian Physiology.** The significance of respiration, digestion, metabolism, excretion, temperature regulation, and hormones in mammalian physiology. II; 1 unit. Prerequisite: Courses totaling twenty hours in chemistry, animal biology, or both, beyond the introductory freshman courses; consent of instructor. STEGGERDA.

331. **Physico-Chemical Biology, Part I: Radiology.** Same as Biological Sciences 331 and Botany 331. Action of ionizing radiations on living organisms. I or II; 1 unit. Prerequisite: One year of biology, physics, chemistry, and mathematics. QUASTLER.

333. **Physico-Chemical Biology, Part II: Electrobiology.** Same as Biological Sciences 333 and Botany 333. Potentials produced by and effects of potentials upon living organisms. Lectures, student reports, and demonstrations. I or II; ¾ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Ten hours of biology; four hours of physical chemistry; ten hours of physics. PROSSER.

361. **Comparative Physiology.** Same as Zoology 361. A comparison of the general physiology of different groups of animals. I; 1 unit. Prerequisite: Senior standing; three semesters of animal biology; two semesters of chemistry. ANDERSON, PROSSER.

362. **Cellular Physiology.** Same as Zoology 362. A physico-chemical analysis of biological functions common to most living cells. II; 1 unit. Prerequisite: Senior standing; two semesters each of biology and general physics; three semesters of chemistry. ANDERSON.

363. **Endocrinology.** Same as Zoology 363. The glands of internal secretion

with special reference to the vertebrates. I annually; II, 1955-1956 and alternate years; 1 unit. Prerequisite: One semester of elementary zoology or physiology; Zoology 334 or organic chemistry; senior standing. HALL.

PLANT PATHOLOGY

Students may choose a major, joint major, or minor in plant pathology. Work for the degree of Master of Science or Doctor of Philosophy in Plant Pathology is administered by a committee appointed by the Dean of the Graduate College and representing the various departments which conduct research in this field. Before registering, candidates must have the approval of the committee which consists of Professor W. M. Bever (Chairman), Department of Agronomy; Professor L. M. Black, Department of Botany; Professor M. B. Linford and Professor M. B. Linn, Department of Horticulture; and Professor L. R. Tehon, State Natural History Survey.

The following fields are available for specialization in plant pathology: diseases of field crops, forest and shade trees, fruit crops, ornamentals, and vegetable and canning crops. The student may also specialize in physiology of microorganisms, mycology, nematology, or plant virology.

A candidate for the Master of Science degree must meet the general requirements of the Graduate College and must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination before a committee of five staff members. The examination will cover courses which the candidate has completed and in which he is currently registered.

Candidates for the Doctor of Philosophy degree must meet the general requirements of the Graduate College regarding foreign languages, special examinations, minors, and theses.

Beginning graduate students with a grade-point average of at least 3.75 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, are admitted to full standing. Students are not accepted on limited status.

FELLOWSHIPS AND ASSISTANTSHIPS

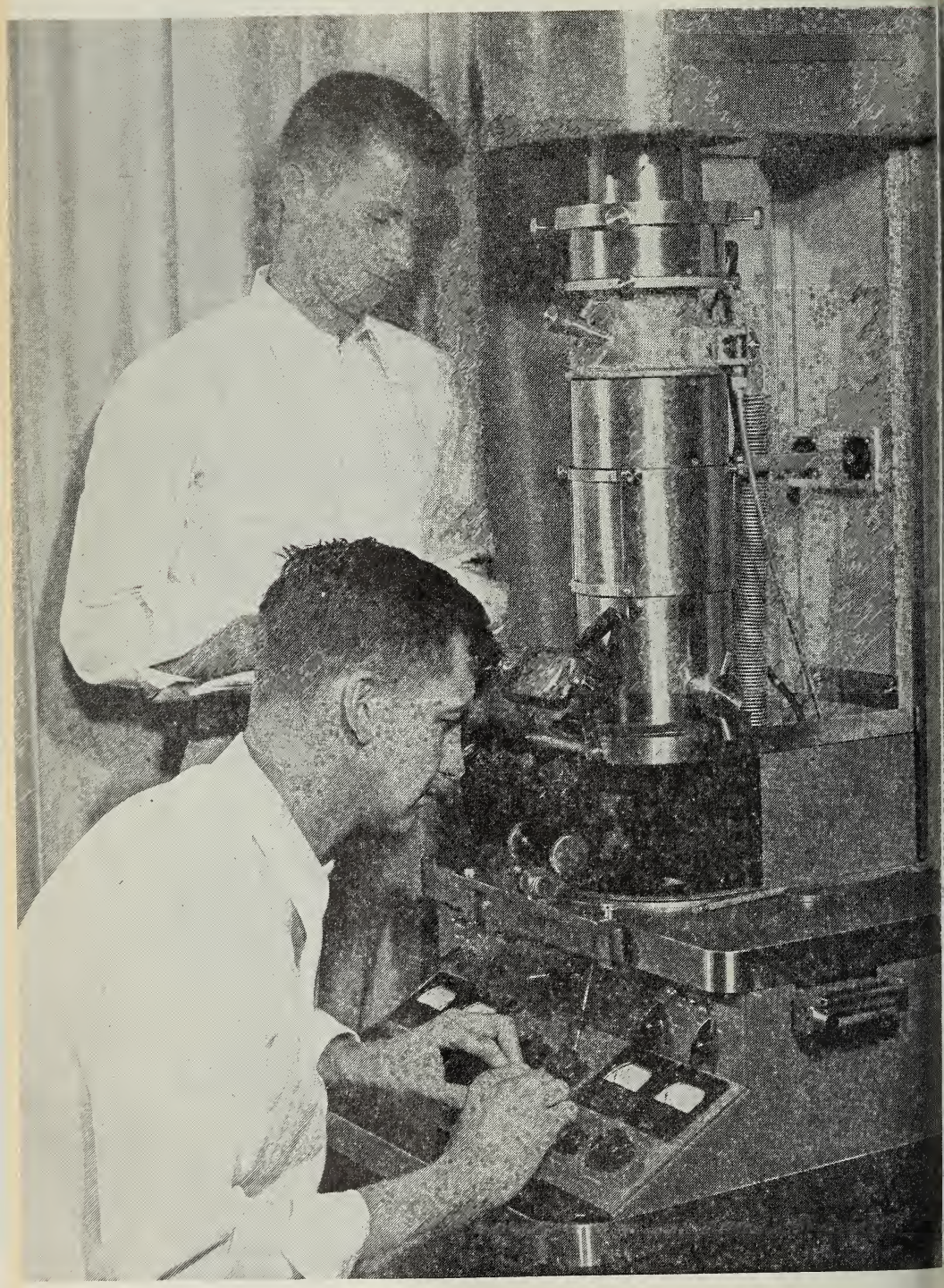
A number of fellowships are available in the Graduate College. For a description of these, refer to the beginning section of the bulletin. In addition, the Department of Agronomy, Botany, Horticulture, and the State Natural History Survey (Section of Applied Botany and Plant Pathology) have research assistantships available for students majoring in plant pathology. Applications for assistantships in plant pathology should be made through the head of one of these departments.

GRADUATE TEACHING FACULTY

Professors: W. M. BEVER (Chairman), L. M. BLACK, D. GOTTLIEB, B. KOEHLER, M. B. LINFORD, M. B. LINN, D. POWELL, L. SHANOR, L. R. TEHON, F. F. WEINARD.
Associate Professor: H. H. THORNBERRY.
Assistant Professor: J. W. GERDEMANN.
Plant Pathologist: D. W. CHAMBERLAIN.

COURSES FOR GRADUATES

401. **Diseases of Forest and Shade Trees.** A survey of the history, symtomology, causes, and control of diseases of trees with assigned reading and per-



The University electron microscopist adjusts the new RCA-EMU ele
microscope for a graduate student interested in research on plant vir
This is one of four instruments in the Electron Microscope Laboratory.

formance of illustrative experiments in the laboratory, greenhouse, and field. II; ½ to 1 unit. Prerequisite: Plant Pathology 317 or equivalent. TEHON.

404. **Plant Virology.** Same as Botany 404 and Horticulture 404. Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, staining, assay, filtration, and purification; control methods; sources of information; history of virology. II; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Consent of instructor. THORNBERRY.

417. **Discussions in Plant Pathology.** Same as Botany 417 and Horticulture 417. Required for majors in plant pathology and as elective for graduate students in plant science. I, II; ¼ unit. GOTTLIEB and staff.

424. **Advanced Plant Virology.** Same as Horticulture 424. Purification and special properties of virus nucleoproteins or selected virus diseases are considered. Different specific topics for concentrated study may be selected for subsequent semesters depending upon the student's interest. A specific topic pertinent to the student's thesis problem may be selected. Theories and original data are to be critically analyzed and evaluated. II; ½ to 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Horticulture 404; consent of instructor. THORNBERRY.

Botany 427. Discussions in Mycology. A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. I, II; ¼ unit. Prerequisite: Consent of instructor. SHANOR.

Botany 471. Advanced Mycology — Special Groups. Special groups of fungi and their activities are considered. Different groups for concentrated study may be selected each semester depending upon the student's interests in mycology. I, II; ½ unit. Prerequisite: Consent of instructor. SHANOR.

Botany 472. Industrial Mycology. The characteristics, relationships, and activities of fungi of industrial importance are considered. Yeasts and mushrooms are included but major emphasis is placed on Mucorales, Aspergilli, Penicillia, and Fungi Imperfecti. I; ½ unit. Prerequisite: Consent of instructor. SHANOR.

491. **Thesis.** Same as Horticulture 491c and Agronomy 491b. Research on the thesis problem in plant pathology. I, II; ½ to 4 units. BEVER, BLACK, CHAMBERLAIN, GOTTLIEB, KOEHLER, LINFORD, LINN, POWELL, TEHON, THORNBERRY, WEINARD.

492. **Research.** Same as Agronomy 492b, Botany 493e, Horticulture 493c. Work may be taken in the following fields subject to approval of one of the staff: fruits, vegetable and canning crops, field crops, ornamentals, forest and shade trees, virology, mycology, physiology of microorganisms, nematodes. I, II; ½ to 4 units. BEVER, BLACK, CHAMBERLAIN, GOTTLIEB, KOEHLER, LINFORD, LINN, POWELL, SHANOR, TEHON, THORNBERRY, WEINARD.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Fruit Diseases.** Same as Botany 307 and Horticulture 307. Symptomatology; laboratory and field studies of representative diseases; control measures. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. POWELL.

308. **Vegetable and Canning Crop Diseases.** Same as Botany 308 and Horticulture 308. Symptomatology; laboratory and field studies of representative diseases; control measures. II; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. LINN.

317. **Plant Pathology.** Same as Agronomy 317, Botany 317, and Horticulture 317.

An introduction to plant pathology. Basic concepts of diagnosis, cause and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science, including Botany 100. BLACK.

Botany 372. **General Mycology.** Structure, classification, and identification of fungi, including those of economic importance. Modification of the course will be made to meet the needs of teachers and prospective teachers during the summer. I; 1 unit. Prerequisite: One year of botany, bacteriology, entomology, or zoology; senior standing or consent of instructor. SHANOR.

377. **Diseases of Field Crops.** Same as Agronomy 377 and Botany 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Plant Pathology 317, or consent of instructor. BEVER, GERDEMANN.

379. **Research Methods in Plant Pathology.** Same as Agronomy 379, Botany 379, and Horticulture 379. Lectures and laboratory techniques for isolation, for culture of and inoculation with plant pathogens, for the evaluation of plant protectants; for the study of the physiology of parasitism and methods of evaluation of data and preparation of manuscripts. I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Plant Pathology 317. GERDEMANN, GOTTLIEB.

POLITICAL SCIENCE

The Department of Political Science offers graduate work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work is conducted in the following special fields: American government and politics; comparative government and politics; international law and relations; public administration; political theory and jurisprudence.

In order to be admitted to graduate work in political science a student must have a grade-point average of at least 3.75 for that portion of the work which represents the last fifty per cent of the hours earned for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. They must also have had a minimum of twenty hours of undergraduate work in political science, economics, sociology, and history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history). If a student making political science his major is taking both of his minors in other departments, one of them must be in history, economics, or sociology.

Several courses given in other departments are so closely related to those in political science that graduate students whose major is political science may be permitted on petition to take such courses as part of their major work. Attention is called to the courses in public law in the College of Law, the courses in public finance in the College of Commerce and Business Administration, the courses in city and regional planning in the College of Fine and Applied Arts, and the courses in municipal and sanitary engineering in the College of Engineering. An extension curriculum in public administration leading to the master's degree is offered at Springfield. This curriculum is designed particularly as in-service training for persons in the various state services.

Graduate students in other departments who choose political science as a minor must have had at least six hours of undergraduate work in political science and three hours in economics, sociology, or history.

FELLOWSHIPS AND ASSISTANTSHIPS

The James Wilford Garner Fellowship in Political Science, carrying a stipend of $1,500, was established in 1951 by a gift to the University from Mrs. Garner

as a memorial to Professor Garner, who served as Head of the Department of Political Science from 1904 to 1938.

Professor John A. Fairlie, who served on the Political Science faculty from 1909 to 1941, bequeathed to the University a sum of money the income from which is used to provide the John A. Fairlie Fellowship in Political Science carrying a stipend of $1,500.

The department participates with the Department of History in the Kendric C. Babcock Fellowship established under the will of Dean Kendric C. Babcock. For the third year these appointments carry a stipend of $1,400, and postdoctoral grants carry a stipend of $2,400. Nominations for these fellowships are made by the heads of the departments of Political Science and History.

Application forms for these fellowships may be obtained from the Graduate College.

The department has available a certain number of teaching assistantships which carry the requirement of six hours of teaching per week in elementary sections. Students must have received the master's degree to be considered for these positions. Correspondence regarding them should be addressed to the Chairman of the Department.

GRADUATE TEACHING FACULTY

Professors: F. G. Wilson (Chairman of Department), C. A. Berdahl, R. Dangerfield, C. B. Hagan, V. Jobst, C. M. Kneier, C. F. Snider.
Associate Professors: J. M. Edelman, E. G. Lewis, P. Monypenny, J. W. Peltason, J. A. Ranney.
Assistant Professors: G. Manner, T. Page, R. E. Scott.

COURSES FOR GRADUATES

400. **Nature of the State.** Principles, methods, and nature of political science; origin, forms, and functions of the state; sovereignty and liberty; organization and forms of government. S; 1 unit. Wilson.

401. **History of Political Theories.** Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. I; 1 unit. Wilson.

402. **History of Political Theories.** Reading and analysis of the leading political thinkers from the middle of the seventeenth century to the present. II; 1 unit. Wilson.

406. **Municipal Administration.** Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. I or II; 1 unit. Kneier.

410. **Problems in Rural Local Government.** Research in selected topics. I or II; 1 unit. Snider.

412. **Problems in State Government.** Research in selected topics in American state government. I or II; 1 unit. Snider.

420. **Formation of Public Policy.** Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legal procedures, and judicial activity. I or II; 1 unit. Hagan.

421. **Government and the Economic Order.** Same as Mass Communications 421. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. I or II; 1 unit. Hagan.

426. **Political Parties.** Special problems in political parties; methods and materials of research in this field. I or II; 1 unit. Berdahl.

431. **Problems in British Government.** Special topics relating to British government. I or II; 1 unit. LEWIS.

450. **Contemporary Governmental Problems.** Special problems of current importance. Designed especially for students not majoring in political science. S; 1 unit.

451. **Constitutional Law.** Research in selected topics in the American constitutional system. I; 1 unit. Prerequisite: Political Science 351 or equivalent. PELTASON.

465. **Problems in Administrative Management.** An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. I or II; 1 unit. Prerequisite: Political Science 361 or 364, or consent of instructor. MONYPENNY.

466. **Current Administrative Theory.** A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. I or II; 1 unit. MONYPENNY.

471. **Problems in International Organization.** Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. I or II; 1 unit. BERDAHL.

481. **Foreign Relations of the United States.** Special problems in the development and conduct of American foreign policy. I; 1 unit. DANGERFIELD.

485. **International Law.** Research in selected topics. I; 1 unit. JOBST.

486. **International Law.** Research in selected topics. II; 1 unit. JOBST.

491. **Seminar in Political Science and Public Law.** Theses, special problems, reports, discussions, and criticism. I; ½ to 4 units. STAFF.

492. **Seminar in Political Science and Public Law.** Theses, special problems, reports, discussions, and criticism. II; ½ to 4 units. STAFF.

493. **Research in Selected Topics.** Research in selected topics by arrangement with the instructor. I, II; 1 unit. STAFF.

499. **Scope and Methods of Political Science.** Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; techniques for selecting research problems, collecting and interpreting data, and reporting results; the present state of research in political science. I or II; 1 unit. DANGERFIELD.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Municipal Government.** Growth of cities; their legal status; municipal politics and organization in the United States. I; ½ to 1 unit. KNEIER.

306. **Municipal Problems.** Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. II; ½ to 1 unit. Prerequisite: Political Science 305, or Economics 102 and 103, or six hours of political science. KNEIER.

310. **Rural Local Government.** Development of local government in rural America; state-local relationships; legal status of local units; organization

and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. I or II; ½ to 1 unit. SNIDER.

312. **State Government.** The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; reorganization problems in the state; state-local relations; state finance; trends and prospects. Students may not receive credit for both Political Science 110 and 312. I or II; ½ to 1 unit. Prerequisite: Political Science 150 or 191. SNIDER.

315. **Legislatures and Legislation.** The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reorganization. I or II; ½ to 1 unit. Prerequisite: Six hours of political science. HAGAN.

321. **Government and the Economic Order.** A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. I or II; ½ to 1 unit. Prerequisite: Any two courses in political science, or a combination of political science and economics. HAGAN.

325. **Political Parties: Historical Development and Issues.** Nature of American party system; historical development of parties and issues; third or minor parties and their role. I or II; ½ to 1 unit. BERDAHL.

326. **Political Parties: Organization and Methods.** Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. I or II; ½ to 1 unit. BERDAHL.

328. **Political Behavior: The Electoral Process.** A study of the principal characteristics of and influences upon voting behavior in the United States; methods for studying voting behavior and predicting elections; analysis of present alignments in the electorate as revealed by recent elections. I or II; ½ to 1 unit. Prerequisite: Political Science 150 or 191. RANNEY.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. I or II; ½ to 1 unit. LEWIS.

336. **Continental European Governments and Politics.** An analysis of the major political systems of continental Europe; constitutional and legal structures of France, Germany, Italy, the Soviet Union, and Spain; factors in the struggle for power; political and social movements as they affect the European scene; relation of political to economic, religious, and social institutions in Europe. II; ½ to 1 unit. LEWIS.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin-American political institutions; systems of government; public administrative systems; party government; international policies of Latin-American governments. I or II; ½ to 1 unit. SCOTT.

343. **International Relations of Latin America.** Latin-American position and objectives in international affairs, with emphasis on the Latin-American viewpoint; the Monroe Doctrine; the Good Neighbor Policy; the organization of American states and the United Nations; recent relations of specific nations. I or II; ½ to 1 unit. SCOTT.

345. **Theory and Practice of Democratic Government.** Theories of the nature and conditions of democracy; contemporary democratic institutions compared

and analyzed. I or II; ½ to 1 unit. Prerequisite: Political Science 150 or 191. RANNEY.

346. **Theory and Practice of Communism.** A survey of the international communist movement. The origins of modern communism, and the nineteenth century development of its doctrines; the Russian Revolution; Lenin and Stalin; the U.S.S.R. as a model for communism; the regional development of Communist Parties. I or II; ½ to 1 unit. Students may not receive credit for both Political Science 346 and 396. WILSON.

351. **American Constitutional System.** Judicial interpretation of the constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. I; ½ to 1 unit. Prerequisite: Political Science 150 or 191. PELTASON.

354. **The Constitution and Industrial Legislation.** Scope of national regulatory power; commerce clause, taxing power; spending power; scope of state regulatory power; police power and due process limitations. II; ½ to 1 unit. Prerequisite: Any two courses in political science, or a combination of political science and economics. PELTASON.

355. **The American Constitution and Civil Liberties.** A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. I or II; ½ to 1 unit. Prerequisite: Political Science 150 or 191. PELTASON.

356. **Administrative Law in the United States.** A study of the powers of administration, of the legal requirements for and the limits on the exercise of such powers, of the internal and external means of safeguarding individual rights, and of the enforcement of the responsibility of administrative officers both politically and legally. II; ½ to 1 unit. Prerequisite: Political Science 305, 351, 354, or 361 (any one), or consent of instructor. MONYPENNY.

359. **Jurisprudence.** Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. I or II; ½ to 1 unit. Prerequisite: Political Science 150 or 191. MANNER.

361. **Introduction to Public Administration.** Development of administrative organizations; administration and the executive, legislature, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. I; ½ to 1 unit. Prerequisite: Political Science 150 or 191. MONYPENNY.

364. **National Administration.** Creation and development of the national administrative organization; the executive departments; regulatory, service, and staff agencies; special organization for emergency and war; efforts at reorganization and coordination. I or II; ½ to 1 unit. Prerequisite: Six hours of political science, including either Political Science 150 or 151. MONYPENNY.

365. **Theory and Administration of Federal Labor Law.** Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. I or II; ½ to 1 unit. Prerequisite: Political Science 150 or 191. EDELMAN.

367. **Public Fiscal Administration.** The public budget in representative governmental units — preparation and control, the budget as a tool of policy, audit functions, supply services, claim settlement, fund and debt management, relation to organization and methods analysis and personnel utilization,

and intergovernmental fiscal relations. I or II; ½ to 1 unit. Prerequisite: Political Science 361 or consent of instructor. PAGE.

368. **Public Personnel Administration.** Same as Labor and Industrial Relations 368. An analysis of personnel management in government. Recruitment and selection, job and salary classification, work standards, training, and the role of labor and professional organizations in the public services are considered in the light of current theory and practice. I or II; ½ to 1 unit. Prerequisite: Political Science 361 or consent of instructor. PAGE.

371. **International Organization.** General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the League of Nations, the United Nations, and related agencies. I or II; ½ to 1 unit. BERDAHL.

372. **International Organization.** The problem of war and security; pacific settlement of disputes; the functioning of the United Nations and other international agencies in respect to economic and social problems. I or II; ½ to 1 unit. BERDAHL.

373. **International Administration.** International administrative agencies; international unions and other agencies for functional purposes; organization, procedure, and personnel of international secretariats; budgets and financial administration; international territory; mandates and trusteeships. I or II; ½ to 1 unit. Prerequisite: Political Science 371 or 372, or equivalent. BERDAHL.

381. **American Foreign Relations.** Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty making power; development of foreign policy. I or II; ½ to 1 unit. Prerequisite: Six hours of political science. DANGERFIELD.

382. **Contemporary American Foreign Policies.** Study of the major foreign policy decisions currently confronting the United States government — analysis of background, principal issues, alternative actions, formulation of policies. I or II; ½ to 1 unit. DANGERFIELD.

384. **International Relations.** An examination of the nature of the national state system, of the forces affecting international relations, of the sources of conflicts in international politics, and of their solution by power politics or by international cooperation. I or II; ½ to 1 unit. MANNER.

385. **International Law.** Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. I; ½ to 1 unit. JOBST.

386. **International Law.** Responsibility, intercourse, and redress of differences between states. II; ½ to 1 unit. JOBST.

393. **History of Political Theory.** A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of Christian political thought and the Middle Ages; political theory during the Renaissance, Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, Utopianism, and socialism. I or II; ½ to 1 unit. WILSON.

396. **Contemporary Political Theory.** Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; anti-democratic thought and totalitarian regimes. I or II; ½ to 1 unit. Students may not receive credit for both Political Science 396 and 346. WILSON.

397. **American Political Theory.** A survey of American political thought from colonial times to the present. I; ½ to 1 unit. WILSON.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Fields. Four principal fields of specialization are recognized: general experimental psychology; industrial psychology; clinical psychology and counseling; and social psychology.

Admission. In addition to the general requirements of the Graduate College, the candidate for admission to graduate study in psychology must meet the following undergraduate requirements: (1) a minimum of fifteen semester hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) one course in another laboratory science; (4) a grade-point average of at least 4.0 in courses representing the last fifty per cent of the hours completed for the bachelor's degree, exclusive of physical education and military training. Students are not admitted on limited status. Preference is given to students who have taken mathematics and two years of French or German. These are minimal requirements. Because it is necessary to limit the number of admissions to graduate study in psychology, it will not be possible to accept all applicants who meet the minimal requirements.

Minor. The prerequisite for a graduate minor in psychology is twelve semester hours in undergraduate psychology, including a course in statistics.

Programs and Requirements for Degrees. All graduate students are required in the first year to enroll for "core" courses in quantitative methods, and in historical and systematic psychology. These courses total two units of credit each semester and constitute half of a normal full-time program for the year. The remainder of the work in the first year is organized under area programs representing the four fields listed above, and students are encouraged to elect one of these area programs. It is possible to change fields with a minimum of dislocation and loss of time, because the first year is devoted largely to basic courses.

The degree of Master of Arts is awarded to candidates who complete satisfactorily eight units of course work, who present an acceptable thesis, and who pass the comprehensive examination.

Programs for the degree of Doctor of Philosophy are normally organized under the department's four designated fields of specialization, but individual programs may be arranged to meet the special needs of students. Such special programs usually are planned at the end of the first year.

In the fields of general experimental psychology and social psychology the degree of Doctor of Philosophy is awarded to students who (1) complete satisfactorily the standard area program, including the minor(s) and electives — a minimum of sixteen units; (2) pass all examinations required by the Graduate College and by the Department of Psychology; and (3) present an acceptable doctoral thesis, based upon the equivalent of at least eight units of work.

In the fields of industrial psychology and of clinical psychology and counseling the doctoral candidate must meet the three general classes of requirements just described. In addition, he must complete one full year of internship or field work in an agency approved by the Department of Psychology. Normally this work is done in the student's third year of graduate study. With special departmental approval the internship requirement may be met in the fourth year, following the completion of the other doctoral requirements.

A special doctoral program for the training of school psychologists is offered

jointly by the Department of Psychology and the College of Education. Students may enroll in either department for this program, which is administered by the Joint Committee on School Psychology. A minimum of three years of graduate study is required, plus an internship of twelve months.

FELLOWSHIPS AND ASSISTANTSHIPS

The Department of Psychology appoints each year a substantial number of part-time teaching and research assistants. Initial stipends of half-time teaching assistants are $1,350 for the academic year. Half-time research assistants are appointed for the academic year at initial stipends of $1,350. Application forms and other information concerning assistantships may be secured from the Head of the Department of Psychology, 314 Gregory Hall.

Graduate students in psychology may apply for University Fellowships which are awarded by the Graduate College. Application must be filed with the Dean of the Graduate College before February 15 of the academic year preceding that for which the fellowship is desired. (See page 26 of this catalog.)

In the field of clinical psychology three special kinds of financial aid are available: (1) full-time internships in the Psychological Clinic for third- and fourth-year graduate students, with a stipend of $2,000 for the calendar year; (2) fellowships provided by the United States Public Health Service, with stipends varying from $1,200 to $2,400 per year; (3) part-time internships of the United States Veterans Administration, with stipends varying with the Civil Service classification of the trainee and the amount of time spent in the Veterans Administration hospital. Application forms and other information can be secured from the Head of the Department of Psychology, 314 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: L. H. Lanier (Head of Department), R. B. Cattell, W. M. Gilbert, G. D. Higginson, J. M. Hunt, W. E. Kappauf, L. L. McQuitty, O. H. Mowrer, L. I. O'Kelly, C. E. Osgood, L. A. Pennington, R. Stagner, P. T. Young.

Associate Professors: J. Cohen, T. N. Ewing, G. R. Grice, L. A. Hellmer, A. K. Jonietz, W. G. McAllister, L. M. Stolurow, A. C. Williams, Jr.

Assistant Professors: R. E. Brown, N. H. Eisen, F. E. Fielder, P. V. Marchetti, D. R. Peterson, H. Rosen, I. D. Steiner, D. L. Thistlethwaite, C. F. Wrigley.

COURSES FOR GRADUATES

The prerequisites stated are appropriate for graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all of the prerequisites.

401. History of Psychology. I, II; 1 unit. Prerequisite: Fifteen hours of psychology. Grice.

402. Systematic Psychology. A critical analysis and comparison of modern and contemporary psychological theory. I, II; 1 unit. Prerequisite: Psychology 401. Lanier.

406. Quantitative Methods, I. A lecture and laboratory course in the application and development of quantitative methods in psychological research. I, II; 1 unit. Prerequisite: Fifteen hours of psychology, including Psychology 135, or equivalent. Kappauf.

407. Quantitative Methods, II. A continuation of Psychology 406. I, II; 1 unit. Prerequisite: Psychology 406. Kappauf.

411. **Advanced Physiological Psychology.** Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation, learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. I, II; 1 unit. Prerequisite: Fifteen hours of psychology, including Psychology 311, or equivalent. O'Kelly.

415. **Experimental Sensory Psychology.** A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. II; 1 unit. Prerequisite: Fifteen hours of psychology, including a laboratory course in experimental psychology, or equivalent. Cohen.

416. **Experimental Psychodynamics.** Experimental methodology in the study of behavior dynamics, including laboratory work on motivational variables in perception, learning, symbolic behavior, and personality. I, II; 1 unit. Prerequisite: Psychology 441, or equivalent.

417. **Experimental Psychology of Learning, I: Basic Processes.** A study of experimental investigation of basic learning processes with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. I; 1 unit. Prerequisite: Fifteen hours of psychology. Grice.

418. **Experimental Psychology of Learning, II: Human Learning.** Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. II; 1 unit. Prerequisite: Psychology 417 or consent of instructor. Stolurow.

419. **Advanced Comparative Psychology.** A critical examination of specific techniques used and of representative results obtained in the study of animal behavior. Laboratory demonstrations and individual research problems. II; 1 unit. Prerequisite: Fifteen hours of psychology, including Psychology 345, or equivalent. McAllister.

421. **Problems in Motivation.** I, II; 1 unit. Prerequisite: Six units of graduate credit in psychology, or equivalent. Young.

426. **Experimental Psychology of the Communication Process.** Same as Mass Communications 426. A critical survey of methods and theories in the psychological study of the communication process, with the emphasis upon the development of symbolic behavior, experimental semantics, and frequency studies; application will be made to various problems in social science. II; 1 unit. Prerequisite: Six units of graduate credit in psychology or consent of instructor. Osgood.

427. **Human Factors in Equipment Design.** Experimental psychology applied to the design of machines and equipment for human use, with special reference to aviation and aircraft. I, II; 1 unit. Prerequisite: Four units of graduate credit in psychology, including a graduate laboratory course in psychology, or equivalent. Williams.

431. **Personnel Psychology in Business and Industry.** The application of psychological principles and procedures to personnel methods in industry and business. I, II; 1 unit. Prerequisite: Fifteen hours of psychology, including Psychology 135 and 290, or equivalent. Marchetti.

433. **Research Methods in Personnel and Industrial Psychology, I.** Survey and critical appraisal of the application of research methods to personnel and industrial problems. I, II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406, 407, and 431, or equivalent.

434. **Research Methods in Personnel and Industrial Psychology, II.** A continuation of Psychology 433. I, II; 1 unit. Prerequisite: Psychology 433.

437. **Psychogenics of Industrial Conflict.** Same as Labor and Industrial Relations

437. Offers an opportunity for advanced study, through readings in current literature, lectures, field projects, and visiting speakers, of the psychological origins of industrial conflict. Theoretical analysis of the perceptions, emotions, motives, and frames of reference of managerial executives, workers, and union officials is supplemented by visits to industrial enterprises and union headquarters. Each student is required to do an intensive library and field study of some specific problem in labor-management relations. II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 357, or equivalent. STAGNER.

441. **Personality Dynamics.** Systematic study of the structure of personality, the basic principles of behavior dynamics, and the determinants of personality development. I; 1 unit. Prerequisite: Fifteen hours of psychology, including Psychology 338, or equivalent. HUNT.

442. **Behavior Disorders.** A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. I, II; 1 unit. Prerequisite: Psychology 441 or equivalent. HUNT.

443. **Psychodiagnostics, I.** Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and achievement. I, II; 1 unit. Prerequisite: Fifteen hours of psychology, including Psychology 290, or equivalent.

444. **Psychodiagnostics, II.** Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. I, II; 1 unit. Prerequisite: Psychology 443; consent of instructor.

445. **Psychodiagnostics and Psychotherapy, I.** This course provides didactic training and supervised experience in psychodiagnostics and psychotherapy. Students are required to enroll concurrently in Psychology 463-464, as a means of relating the practicum experience with the study of research methodology. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 441-442 and 443-444; consent of instructor. EISEN, GILBERT, HELLMER, JONIETZ.

446. **Psychodiagnostics and Psychotherapy, II.** A continuation of Psychology 445. II; 1 unit. Prerequisite: Psychology 445; consent of instructor. EISEN, GILBERT, HELLMER, JONIETZ.

448. **Theory and Research in Psychotherapy.** Study and analyses of clinical recordings in the light of contemporary theory of neurosis, with special reference to research problems and methods. I, II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 445, or consent of instructor. MOWRER.

451. **Advanced Social Psychology.** A systematic and critical treatment of individual behavior variables in relation to group variables. I, II; 1 unit. Prerequisite: Fifteen hours of psychology, including Psychology 255, or equivalent. STEINER.

453. **Research Methods in Social Psychology, I.** A systematic study of experimental methods and techniques in social psychology, with accompanying laboratory work in the design of research. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406, 407, and 451, or equivalent.

454. **Research Methods in Social Psychology, II.** A continuation of Psychology 453. II; 1 unit. Prerequisite: Psychology 453.

455. **Psychology of Opinion and Attitude.** Same as Mass Communications 455. Theory and practice in measurement of opinion and attitude formation and

change. Attitude scales; factors affecting morale; interpretation of results from social and psychological characteristics of the population; intensity of attitudes; relations among attitudes and opinions. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 451, or consent of instructor. THISTLETHWAITE.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision-making, group cohesiveness, and productivity. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 451, or equivalent. STEINER.

461. **Advanced Child Psychology.** I or II; 1 unit. Prerequisite: Fifteen hours of psychology.

463. **Research Methods in Clinical Psychology and Personality, I.** The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406-407, 441, and 443-444. HUNT.

464. **Research Methods in Clinical Psychology and Personality, II.** A continuation of Psychology 463. II; 1 unit. Prerequisite: Psychology 463. HUNT.

465. **Factor Analysis in Psychology.** The psychological theory and the procedures of factor analysis, including factoring, rotation, the psychological nature of factors, and the place of factor analysis in science. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406 and 407, or equivalent. WRIGLEY.

466. **Test Construction.** A systematic development and critical consideration of the theories, methods, and techniques in test construction. I, II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406 and 407, or equivalent. MCQUITTY.

467. **Personality Theory.** A survey of major theories regarding human personality, the key concepts in these theories, and the relation between theory and research findings on personality. I, II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 441, or equivalent. STAGNER.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior. Special emphasis on theories concerning the learning process, including the work of Hull, Tolman, and Guthrie. I, II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 401 and 402. GRICE.

469. **Scientific Method in Psychology.** An analysis of the general nature of scientific inquiry, with special reference to the logic of contemporary psychology. Consideration is given to the nature and use of psychological concepts; hypothesis and deduction; experimental methodology; the construction of psychological theory. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 401 and 402. LANIER.

483. **Seminar in Psychology of Speech Disorders.** Advanced theoretical study of psychological disorders of speech such as stuttering, delayed speech, and hysterical conditions; survey of current theory and research. I or II; 1 unit. Prerequisite: Consent of instructor.

490. **Individual Research.** For graduate students who wish to conduct research on special problems not included in graduate theses. I or II; ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

491. **Research and Thesis (A.M.).** I, II; ½ to 2 units. STAFF.

492. **Research and Thesis (Ph.D.).** I, II; ½ to 4 units. STAFF.

493. **Research Seminar.** Discussion of current topics in their historical setting, with special emphasis on research problems. I, II; ½ to 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 401, 402, 406, and 407; consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Physiological Psychology.** A study of the physiological basis of behavior, including sensory processes, motivation, emotion, learning, and intelligence. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology; Physiology 103 or 106, or Zoology 101. O'KELLY.

326. **Motivation and Emotion.** The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology. YOUNG.

330. **Advanced Experimental Psychology.** A survey of experimental techniques and subject matter in the fields of psychophysics and measurement, sensory processes, attention and perception, motivation and emotion, learning and memory, and motor activity. Lectures and laboratory. I, II; ½ to 1 unit. Prerequisite: Psychology 100, 103, or 106; a course in statistics. COHEN.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology; junior standing except for those in the premedical curriculum who may take the course as second semester sophomores with four hours of psychology. PENNINGTON, PETERSON.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. I or II; ½ to 1 unit. Prerequisite: Six hours of psychology, or Psychology 100, 103, or 106, and one course in zoology. MCALLISTER.

348. **The Psychology of Learning.** A survey of the basic facts and theories of the learning process. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology. Graduate credit not allowed for both Psychology 348 and Psychology 351 and 352. GRICE.

351. **Advanced General Psychology, I.** An intensive survey of sensory processes, perception, and fundamentals of learning, with emphasis on the relation of facts to contemporary theories. I; ½ to 1 unit. Prerequisite: Six hours of psychology; senior standing. Graduate credit not allowed for both Psychology 348 and 351. KAPPAUF, OSGOOD.

352. **Advanced General Psychology, II.** An intensive survey of motivation, emotion, human learning, symbolic processes, and individual differences, with emphasis on the relation of facts to contemporary theories. II; ½ to 1 unit. Prerequisite: Six hours of psychology; senior standing. Graduate credit not allowed for both Psychology 348 and 352. OSGOOD.

353. **Psychology of International Relations.** Psychological insights into the problems of international relations: nationalism, war and peace, international conferences. Individual differences due to nationality differences and the problems raised by international contacts. II; ½ to 1 unit. Prerequisite: Psychology 100 and any one of the following: Psychology 150, Sociology 110, 212, or Anthropology 260; and, in addition, three hours of advanced courses in the international affairs curriculum. Foreign students by consent of instructor. STAGNER.

357. **Psychology of Industrial Conflict.** Same as Labor and Industrial Relations 357. An analysis, in terms of the behavior of individuals, of the causes and

possible solutions of industrial conflict. I or II; ½ to 1 unit. Prerequisite: Psychology 100 or equivalent; Psychology 145, Economics 240, or Sociology 318. Rosen.

SOCIAL SCIENCES

A special program leading to the degree of Master of Arts in the Social Sciences is offered to students through the Division of the Social Sciences (including economics, geography, history, philosophy, political science, psychology, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 3.5 for that portion of the work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, and must be acceptable to the adviser for the program. Students on limited status will be admitted.

The degree of Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work which are mandatory for the major. At the completion of his studies the student must pass an examination covering the studies and held by the committe as a whole.

The Chairman of the Division of Social Sciences is Associate Professor Richard Dewey, 323 Gregory Hall. The general adviser for this degree is Professor C. B. Hagan, 301 Lincoln Hall.

Candidates for the degree of Master of Arts in the Teaching of Social Studies must earn four units in social studies, three units in education, and one unit in electives. Requirements are (1) social studies selected from not more than three of the following: economics, geography, history (at least two units), philosophy, political science, sociology, four units; (2) two of the following courses: Education 301, 302, 303, 304, one unit; Education 311 and 312, one unit; and Education 456, one unit. The courses in social studies and the electives must be selected with the approval of the adviser. The electives may be in the social studies, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the division. No limited status students will be admitted to the program.

The adviser for candidates for this degree is Professor F. C. Dietz, 325 Lincoln Hall.

SOCIAL WORK

The School of Social Work offers two years of graduate professional study leading to the degree of Master of Social Work. Although the basic curriculum of the School is the same for all students, there are opportunities for specialization in case work and group work. Students specializing in group work have their classes at Navy Pier in Chicago and field placements in group work agencies in the city. Those specializing in case work have their academic work in Urbana and field placements in selected agencies in or near Champaign-Urbana.

The School has established an Admissions Committee which is responsible for reviewing all applications. The Committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and pre-professional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. Although no specific undergraduate grade-point average is specified, the applicant must give evidence of ability to carry graduate work.

In additon to scholastic achievement, the Admissions Committee attempts to determine the applicant's personal suitability for professional education in social work. Preference is given to applicants between the ages of twenty-one and thirty-five, but consideration is given to older applicants who have demonstrated their capacity for social work practice. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthy relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas will disqualify an applicant.

Because of the limited number of field work placements in acceptable social agencies, the School is compelled to limit its enrollment to the number of field work placements available.

Application must be made to the School of Social Work. The special bulletin issued by the School may be obtained by writing to the Director, School of Social Work, 1204 West Oregon Street, Urbana.

SCHOLARSHIPS AND ASSISTANTSHIPS

Several scholarships are provided by social agencies for students who are interested in accepting employment after graduation. Local, state, and national agencies have special scholarships of varying amounts. It is suggested that the applicant consult the School regarding these provisions.

A limited number of part-time assistantships are available for second-year students who have demonstrated academic ability and skills needed in research or other assignments. Application should be made to the Director of the School.

GRADUATE TEACHING FACULTY

Professor: Marietta Stevenson (Director of School of Social Work).

Associate Professors: R. J. Artigues, Edith L. Nagel, Florence L. Poole, W. P. Simon.

Assistant Professors: S. Low, J. E. McDonald, Mary E. Reese, D. Katharine Rogers.

Lecturers: Evelyn Eddy, Ann E. Heilman, L. Hellmer, Mary S. Kunst, J. D. McKinney, D. P. Morris, M. Samter, M. A. Sklansky, R. Westfall, B. Zimmerman, Carle Clinic Physicians.

COURSES FOR GRADUATES

421. **Social Work Methods, I.** A course in the principles and practice of social work integrating classroom and field instruction. Sections A1 and A2 are required of all students. In addition, Sections B1 and B2 are required of case work majors and Sections C1 and C2 of group work majors. I; 2 to 4 units.

Section A1. **Social Work Theory.** This section includes consideration of the underlying philosophy and concepts on which social work is based; generic principles of social work method which are applicable to all areas of social work practice; role of the social worker in helping individuals and groups;

basic elements in recording, budgeting, programming; case work-group work interrelationships; referrals. One hour weekly. NAGEL, SIMON.

Section A2. Research. The purpose of this section is to acquaint the student with the major sources of statistical data needed by the social worker, and to help him acquire facility in the use of such data. Students will read and interpret simple statistical materials and apply simple statistical methods to social work material. One hour weekly. LOW.

Section B1. Social Case Work. The purpose of this section is to help the student use the basic principles of social work in the practice of social case work. Through discussion of case material from various settings and from his own field experiences the student is helped to understand the social case work process and to use this understanding in helping the client. Two hours weekly. NAGEL.

Section B2. Field Instruction in Social Case Work. Instruction is based on the student's own practice and is designed to help him develop skill in social case work. The student is assigned to a social agency where he has responsibility for carrying selected cases under the supervision of a qualified field instructor. MCDONALD, NAGEL, REESE, and field instructors.

Section C1. Social Group Work. The purpose of this section is to help the student use the basic principles of social work in the practice of social group work. Discussion is focused on helping the student understand the dynamics of the group process and the meaning of program activities and to use this understanding to help the individual and the group develop a capacity for creative and effective relationships. Record material is used as the basis for discussion. Two hours weekly. SIMON.

Section C2. Field Instruction in Social Group Work. Instruction is based on the student's own practice and is designed to help him develop skill in social group work. The student is assigned to a social agency where he has responsibility for direct work with selected groups under the supervision of a qualified field instructor. SIMON and field instructors.

422. **Social Work Methods, II.** This course includes a more extensive analysis and application of the principles of case work and group work and the introduction of the social work process in community organization. Sections A1 and A2 are required of all students. In addition, Sections B1 and B2 are required of case work majors and Sections C1 and C2 of group work majors. II; 2 to 4 units. Prerequisite: Social Work 421.

Section A1. Community Organization. This section is designed to help the student understand the community organization process at the neighborhood, city, state, and federal levels, with special emphasis on social work method in planning, coordinating, and helping the community to use health, welfare, and leisure-time services. Content is presented through lecture-discussion method, group study projects, and examination of process records. One hour weekly. NAGEL, SIMON, TOOLE.

Section A2. Research. The purpose of this section is to acquaint the student with the aims and methods of research in social work. Illustrative studies are analyzed. Basic principles in planning and carrying out studies of various types are considered in preparation for the second-year research project. One hour weekly. LOW.

Section B1. Social Case Work. This section, a continuation of Social Work 421 B1, is designed to help the student increase his knowledge and improve his skill in the practice of social case work. Two hours weekly. NAGEL.

Section B2. Field Instruction in Social Case Work. A continuation of the first semester of field instruction. Two days weekly. MCDONALD, NAGEL, REESE, and field instructors.

Section C1. Social Group Work. This section, a continuation of Social Work 421 C2, is designed to help the student increase his knowledge and improve his skill in the practice of social group work. Two hours weekly. SIMON.

Section C2. Field Instruction in Social Group Work. A continuation of the first semester of field instruction. Two days weekly. SIMON and field instructors.

423. **Social Work Methods, III.** This second-year course includes further emphasis on the student's understanding and skill in social work with broader consideration of practice in various settings. Section A1 is required of all students. In addition, Sections B1 and B2 are required of case work majors and Sections C1 and C2 of group work majors. I; 2 to 4 units. Prerequisite: Social Work 422.

Section A1. Social Work Settings. This section is designed to help students examine and understand the use of social work method in different settings. The student is helped to develop ways of determining the nature and content of social work services in various settings and methods of developing collaborative working relationships with other services in the setting. Consideration is given to some of the content specific to various kinds of agencies in which social work is practiced. One hour weekly. POOLE.

Section B1. Social Case Work. This section is designed to broaden and deepen the student's understanding of social case work and to help him increase his skill in practice. Consideration is given to both short-time and continuing relationships and to the integration of social work service with the services of other disciplines. Case material from various settings is introduced by the instructor and students. Two hours weekly. POOLE.

Section B2. Field Instruction in Social Case Work. In the third semester of field instruction the student's assignment is in a setting different from that of the first year. Three days weekly. POOLE and field instructors.

Section C1. Social Group Work. The use of the social group work method is discussed with particular attention to the social group work process as related to variations in type, size, and purpose of group. Special consideration is given to advanced material in use of program content and to the role of the group worker in departmental program planning. Two hours weekly. SIMON.

Section C2. Field Instruction in Social Group Work. In the third semester of field instruction the student's assignment includes more complex group problems and elementary administrative and supervisory responsibilities. Emphasis is placed on widening and deepening the student's skill in practice as represented in advance use of program, relationship of group achievement to agency purpose, departmental program planning, and supervision of group leaders. Three days weekly. SIMON and field instructors.

424. **Social Work Methods, IV.** A continuation of Social Work Methods III with the addition of specific material on methods of supervision and administration in social work. Section A1 is required of all students. In addition, Sections B1 and B2 are required of case work majors and Sections C1 and C2 of group work majors. II; 2 to 4 units. Prerequisite: Social Work 423.

Section A1. Supervision and Administration. The focus of this section is the social work process in administration and supervision. Supervisory and administrative responsibilities are examined to determine the basic elements of each and the nature of the relationships involved. Criteria and methods for evaluation are discussed. Illustrative case material is used. One hour weekly. SIMON.

Section B1. Social Case Work. This section is a continuation of Social Work 423 B1 with additional emphasis on presentation by students of material

drawn from their own practice. The student is helped to identify his own developing skill and to examine and work on areas in which he needs further development. Two hours weekly. POOLE.

Section B2. **Field Instruction in Social Case Work.** A continuation of the third semester of field instruction. Three days weekly. POOLE and field instructors.

Section C1. **Social Group Work.** This section includes further discussion of principles and practice in social group work with emphasis on the student's ability to present, analyze, and evaluate material from his own practice. Two hours weekly. SIMON.

Section C2. **Field Instruction in Social Group Work.** A continuation of the third semester of field instruction rounding out the student's agency field experience and emphasizing his growing skill as a social group worker. Three days weekly. SIMON and field instructors.

451. **Dynamics of Human Development, I.** This course is designed to increase the student's understanding of the development of the individual. Integrated material from the fields of medicine, psychiatry, psychology, and anthropology is presented. Emphasis is placed on changes which the individual undergoes as he moves through life. Lectures are presented by representatives of other professions. Discussion of the social worker's use of this material is led by the social work instructor. I; 1 to 2 units. NAGEL, POOLE, and lecturers.

452. **Dynamics of Human Development, II.** This course is a continuation of Dynamics of Human Development, I. II; 1 to 2 units. Prerequisite: Social Work 451. NAGEL, POOLE, and lecturers.

453. **Dynamics of Human Development, III.** Medical information is presented concerning major infectious and chronic diseases, and mental disorders caused primarily by infectious agents. The interrelationship of the physical and emotional aspects of the causation and management of the diseases is discussed. Consideration is given to environmental factors influencing these diseases, and the resources of the community for control programs. The social aspects of illness and medical care, the meaning of illness to the individual and his family, and methods of helping the patient use health and medical facilities are included throughout the course. Instruction is shared by physicians and a member of the social work faculty. I; 1 to 2 units. Prerequisite: Social Work 452. REESE and lecturers.

454. **Dynamics of Human Development, IV.** In this course there is discussion of the dynamics of neuroses and psychoses, and the social implications of these disorders. Emphasis is on the emotional reactions manifested as a result of the individual's attempt to maintain a functioning balance. Discussion is based on student's material from various settings, and on material presented by the instructors. Instruction is shared by a psychiatrist and a member of the social work faculty. II; 1 to 2 units. Prerequisite: Social Work 452. REESE and lecturers.

461. **Special Studies in Social Work, I.** Independent or group study in areas of special interest, application of social work principles to special problems or settings. I, II; 1 to 2 units. STAFF.

462. **Special Studies in Social Work, II.** Independent or group study in areas of special interest, application of social work principles to special problems or settings. I, II; 1 to 2 units. STAFF.

481. **Social Welfare Organization, I.** A course covering the current services and organization for social welfare with emphasis on the political, social, and economic forces giving rise to their development. Attention is given to the English and early American experiences, to the emerging specialized services,

and to the contribution of private philanthropy; the expansion of public responsibility from local to state to state-federal; basic legal concepts; the impact of the war economy on the social services; and the expansion of American social welfare activities in foreign countries and in the United Nations Organization. I; 1 to 2 units. ARTIGUES.

482. **Social Welfare Organization, II.** A study of the principles and content of the programs for income maintenance, health and medical care, family counseling, child welfare, and informal education. Consideration is given to social insurance, work relief, employment services, labor standards, and public assistance, with focus on basic premises, content, and objectives, and on the function each performs in maintaining minimum protection against economic want. Both public and private programs are examined in their relation to the prevention and treatment of incapacity and to the restoration of social functioning of individuals and groups. II; 1 to 2 units. Prerequisite: Social Work 481. ARTIGUES.

483. **Social Welfare Organization, III.** An analysis of organizational patterns and of the administrative process. The structures of national, state, and local public and private agencies are analyzed from the point of view of their functions and interrelationships and of the influence exerted on them by American political and cultural ideologies. The administrative process is reviewed through examination of policy formulation, the executive function, organization, coordination, authority, field services, personnel, budgeting, and public relations. Social action and the legislative process are reviewed in their relations to agency policy and objectives. I; 1 to 2 units. Prerequisite: Social Work 482. ARTIGUES, STEVENSON.

484. **Social Welfare Organization, IV.** Consideration is given to the integration of the social services through coordinated planning as reflected in both governmental and voluntary planning agencies. The role of research is examined. Current developments and issues are examined, such as the role of social service in our society, the economics of social service, the respective roles of public and private services, and the relationships of the income maintenance programs to each other. II; 1 to 2 units. Prerequisite: Social Work 483. ARTIGUES, STEVENSON.

491. **Research.** A seminar for students working on a group research project providing experience in the application of research methods to current social welfare material. Each student is expected to assume responsibility for one phase of the total investigation. With the approval of the faculty research committee, a student with special qualifications may work on an individual project in lieu of a group project. I; 1 unit. LOW.

492. **Research. Continuation of Social Work 491.** II; 1 unit. LOW.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Introduction to Social Case Work.** This course for employed workers deals with the behavior and attitudes expressed by persons asking for assistance, the feelings thus engendered, and the effects of all of these on the contacts of social case workers with individuals and families. Attention is given to case records selected from social case work practice in public assistance and other community agencies. I, II; ½ unit. MCDONALD, REESE.

316. **Social Services for Children.** This course is designed to acquaint students with the unmet needs of children and the organization of social services to meet those needs. Responsibilities of voluntary as well as public agencies are considered. A survey is made of agencies providing leadership and standard setting in social services for children. I, II; ½ to 1 unit. Prerequisite: Consent of instructor. NAGEL, ROGERS.

320. **The Administrative Process in Social Agencies.** A course concerned with an analysis of the administrative process in social agency administration: the elements of administration in relation to agency policy, structure, and function, and to staff; planning, organization, coordination, command, control, and reporting; the function and relation of the executive to policy making and to the staff; the meaning and use of authority and supervision, and the nature of the supervisory relationship at various levels; personnel and fiscal policy and practices; public relations. I, II; ½ unit. ARTIGUES.

333. **Introduction to Social Group Work.** This course is designed to present background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustration from the field of practice in informal education, recreation, and social group work. I; ½ unit. Prerequisite: Introductory courses in sociology, psychology, social sciences. ROGERS.

SOCIOLOGY AND ANTHROPOLOGY

The Department of Sociology and Anthropology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy in Sociology. Courses in anthropology for graduate students are offered at present as electives and to meet minor requirements for students majoring in other fields. A program of study leading to advanced degrees in anthropology is being developed. Information regarding this program may be obtained by writing to the Chairman of the Department.

The department offers a wide choice of sociology courses designed primarily to give the student a broad training in the fundamentals of principles, theory, and scientific methodology in the general field of sociology. At the same time the department offers opportunities for students to specialize in any one of several fields within the discipline, including rural sociology. Specialized programs to meet the particular needs of each student may be arranged through the selection of appropriate courses with the aid of the adviser, through individualized work on special topics, and through the research connected with the preparation of the dissertation.

Admission. Graduate students electing sociology as their major must have had at least nine hours of undergraduate work in sociology and fifteen hours in one or more of the following subjects: anthropology, economics, genetics, history, philosophy, political science, and psychology. The work in sociology must include Sociology 385 or its equivalent. Students who can not meet these requirements may register for graduate courses but must remove any deficiencies during the first year of residence by taking prescribed courses without graduate credit. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

The admission requirement, in terms of grade-point average, is at least 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training.

Graduate students who elect sociology or anthropology as a minor must have had at least six hours of undergraduate work in the same subject.

Degree of Master of Arts. The requirements for the degree of Master of Arts in Sociology are satisfactory completion of an approved program of eight units of work; preparation of an acceptable thesis; and passing an eight-hour written examination. Preparation for the examination is achieved partly through the

work required in Sociology 489, for which one unit of graduate credit is given. Normally, no more than one unit of credit is given for the Master's thesis.

Degree of Doctor of Philosophy. A student who has earned the master's degree in sociology, or its equivalent, and who desires to continue toward the doctorate will be permitted to do so unless the graduate faculty of the department deem it inadvisable. The student who expects to continue should consult with his adviser for assistance in the selection of a program of study. This program should be arranged partly with a view toward gaining adequate preparation for the preliminary examination. Preparation for this examination is obtained both through formal course work and through a program of individual study and reading.

Candidates for admission to the preliminary examination must be prepared to be examined in six fields of sociology and in the minor field or fields. The preliminary examination consists of a written examination of twenty to twenty-five hours distributed over five days, and a two-hour oral examination. The examination is administered by a committee appointed by the Dean of the Graduate College upon the nomination of the department.

The following fields are covered by the preliminary examination: (1) sociological theory and history of theory; (2) social organization and disorganization; (3) social process; (4) demography, ecology, and community analysis; (5) individual and the group; collective behavior; and (6) methods of sociological research. Information regarding the specific topics included in these fields may be obtained from the adviser.

Upon the recommendation of his adviser, and after he has complied with the relevant regulations of the Graduate College, a student may apply in writing to the Executive Committee of the department for admission to the preliminary examination. If the committee approves the application, a doctoral committee will be appointed and the examination will be scheduled.

The regulations of the Graduate College require that the candidate announce the tentative topic of his doctoral dissertation at the time of the preliminary examination. The student should not proceed upon the execution of his thesis research or writing until he has submitted a complete prospectus of his thesis project to his adviser and doctoral committee and obtained their approval.

ASSISTANTSHIPS

A number of part-time teaching assistantships are available for students who have completed work for the degree of Master of Arts. Candidates for assistantships should apply to the Chairman of the Department.

GRADUATE TEACHING FACULTY

Professors: J. W. Albig, D. E. Lindstrom (On leave), J. C. McGregor, J. H. Steward, D. R. Taft.

Associate Professors: J. E. Hulett, Jr. (Chairman of Department), E. A. Ahrens, R. Dewey, C. L. Folse, O. Lewis, E. H. Shideler, B. F. Timmons.

Assistant Professors: Margaret K. Chandler, R. W. Janes, E. Wolf (Visiting), D. E. Wray.

Lecturer: D. Glaser (Visiting).

Sociology

COURSES FOR GRADUATES

400. **General Sociology.** I or II; 1 unit.

412. **Seminar in Social and Cultural Relations of Personality.** I, II; 1 unit. Hulett.

414. **Social Situation and the Social Act.** An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. I or II; 1 unit. Prerequisite: One unit of graduate credit in sociology. HULETT.

418. **Seminar in Industrial Sociology.** Same as Labor and Industrial Relations 418. Individual research in sociological interpretation of industrial organization; the orientation and motivation of the individual in industry and commerce; labor-management relations as group adjustments; the interrelations of industry and the community. I; 1 unit. Prerequisite: Six hours of sociology, including Sociology 318, or consent of instructor. WRAY.

420. **Seminar in Education for Marriage and the Family.** I or II; 1 unit. Prerequisite: Sociology 220 recommended. TIMMONS.

422. **Theory of Social Groups.** Seminar on comparative analysis of various social groups, their origin, composition, structure, functional organization, and dynamic relationships with other groups. I or II; 1 unit.

423. **The Primary Group.** An intensive analysis of primary groups in terms of types, their structural and functional characteristics, their relationships to other units of social structure, and their role in the socialization processes. Semi-independent research projects is included as part of the course work. I or II; 1 unit. Prerequisite: Sociology 422 or consent of instructor.

424. **Seminar in Penology.** I or II; 1 unit. Prerequisite: Sociology 331 or equivalent. TAFT.

425. **Racial and Cultural Minorities.** A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. I or II; 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology. DEWEY.

430. **Seminar in Social Effects of Poverty, Their Prevention and Treatment.** I or II; 1 unit. Prerequisite: Sociology 230 and undergraduate economics recommended. TIMMONS.

431. **Seminar in Criminology.** I or II; 1 unit. Prerequisite: Sociology 331 or equivalent. TAFT.

432. **Critique of Research in Juvenile Delinquency.** The socialized aspects of the practices which have been developed to control the juvenile offender and to prevent delinquency. I, II; 1 unit. Prerequisite: Sociology 331 or consent of instructor. Sociology 431 recommended.

444. **Seminar in Public Opinion.** Same as Mass Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. I, II; 1 unit. ALBIG.

446. **Opinion Polling Analysis.** Same as Mass Communications 446. The study of current polling practices, organizations, and findings. Evaluation of results in terms of the prediction and interpretation of social behavior. I or II; 1 unit.

447. **Sociology of International Conflict.** A consideration of materials bearing on cultural and sociological aspects of the causation of modern war together with their relationship to political, psychological, and economic aspects. I; 1 unit. TAFT.

473. **The Community in Modern American Society.** Comparative analysis of community life as it is influenced by institutional trends of the larger society. I or II; 1 unit. Prerequisite: Sociology 400. JANES.

476. **Urban Communities and Urbanization.** Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. I or II; 1 unit. DEWEY.

477. **Rural Community Organization.** Same as Agricultural Economics 477. A study of rural community structure, functions, and processes, to give the student a concrete picture of how rural communities operate, and the forces which cause change in the group life of the people living in a rural community. I, II; 1 unit. BAUDER, FOLSE.

480. **Sociological Theory and Method.** Seminar on the methods of scientific research by which original contributions to sociological theory are made. I or II; 1 unit.

481. **Seminar in Culture Integration.** I or II; 1 unit.

482. **Recent Developments in Sociology.** II; 1 unit. ALBIG.

488. **European Sociological Theory.** Selected problems of contemporary sociological thought, e.g., the question of objectivity (sociology of knowledge); what constitutes sociology as a special science; the problem of social dynamics. I or II; 1 unit. Prerequisite: Sociology 100. AHRENS.

489. **Readings in Sociology.** A list of readings required of first-year graduate students who must present themselves for written examination when prepared. I, II; 1 unit.

491. **Research and Thesis.** Preparation of theses. I; ½ to 3 units. STAFF.

492. **Research and Thesis.** Preparation of theses. II; ½ to 3 units. STAFF.

497. **Seminar in Rural Sociology.** Same as Agricultural Economics 497. The use of the scientific method in the study of rural social problems; an analysis of methods used in rural sociological research; an analysis of problems studied in rural sociology; guidance in carrying on research in rural sociology. II; 1 unit. BAUDER, FOLSE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Sociology of Education.** Same as Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. I or II; ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. SHIDELER.

318. **Human Relations in Industry.** Same as Labor and Industrial Relations 318. Sociology of industry and problems of personal adjustment; the emergence of modern industrial and labor organizations and their impact upon community life. I, II; ½ unit. Prerequisite: Psychology 100, Sociology 100, or consent of instructor. CHANDLER, WRAY.

320. **Social Roles.** Comparative study of organized participation of individuals in social life and culture. I or II; ½ unit. Prerequisite: Sociology 100. HULETT.

324. **Penology.** Probation; parole; methods of institutional treatment. I or II; ½ unit. Prerequisite: Sociology 331. TAFT.

331. **Criminology.** Crime from the point of view of personality and social situations. I, II; ½ unit. Prerequisite: Sociology 100; open to prelegal juniors by consent of instructor. GLASER, TAFT.

332. **Prevention and Treatment of Juvenile Delinquency.** I or II; ½ unit. Prerequisite: Sociology 100 or 331. GLASER.

340. **Social Movements.** Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanism. I or II; ½ unit. Prerequisite: Sociology 100, or 104 and 105. SHIDELER.

344. **Public Opinion.** Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. I, II; ½ unit. Prerequisite: Sociology 100. ALBIG.

347. **Sociology of International Conflict.** War as a social process; conflict of national cultures, population pressures; race relations, immigration policies, restrictions on communication, and other elements in the international conflict process; occupation policies in Germany and Japan; implications of social science for changes in the process. II; ½ unit. TAFT.

372. **Contemporary International Migration.** Demographic, cultural, ideological, and other factors in present-day movements of peoples; controlled and compulsory migration; immigrant groups and displaced persons in the United States; national and international migration policies. I, II; ½ unit. Prerequisite: Three hours of sociology or eight hours of social science. TAFT.

375. **Sociology of the Community.** Nature, structure, and functions of the community; types of communities and examples of some better community studies; the relation of the community to the larger social organization. I or II; ½ unit. Prerequisite: Sociology 100; eleven hours of sociology. TIMMONS.

378. **Acculturation in Modern Society.** II; ½ unit. Prerequisite: Five hours of sociology. JANES.

385. **Methods of Sociological Research.** I, II; ½ unit. Prerequisite: Eight hours of sociology.

Anthropology

COURSES FOR GRADUATES

460. **Theories and Methods in Anthropology.** A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. I or II; 1 unit. MCGREGOR.

461. **The Cultural Approach in Anthropology.** Seminar on the historical, comparative, and holistic methods of anthropology. I, II; 1 unit. Prerequisite: Consent of instructor. STEWARD.

462. **Cultural Method and Contemporary Native Populations.** Seminar on the use of anthropological methods in the analysis of native populations, with special reference to studies of communities, classes, castes, and other subcultural groups. I, II; 1 unit. Prerequisite: Consent of instructor or Anthropology 461. STEWARD.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

353. **Southwestern Archaeology.** This course is a detailed study of one archaeological unit in the United States. It covers the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. I or II; ½ unit. Prerequisite: Anthropology 102 and 103, or 107, or consent of instructor. MCGREGOR.

354. **Field Techniques in Archaeology.** Participation in archaeological excavations; techniques, methods, and procedures discussed and practiced in actual working conditions. S; 1 unit. Prerequisite: Anthropology 102 and 103, or 107, or consent of instructor. MCGREGOR.

355. **Laboratory Techniques and Problems in Archaeology.** Laboratory work in the field, studying, evaluating, and writing final report on preceding field work. S; 1 unit. Prerequisite: Anthropology 102 and 103, or 107, or consent of instructor. MCGREGOR.

356. **Physical Anthropology.** The aims and methods of physical anthropology; both osteology and somatology, with emphasis on the human skeleton. II; 1 unit. Prerequisite: Anthropology 102 and 103, or 107; or a course in anatomy or comparative anatomy, physiology, or a course in introductory zoology with consent of instructor. MCGREGOR.

361. **Ethnology of Middle America.** A survey of the peoples and cultures of Middle America with special emphasis upon Mexico and Guatemala. The course begins by placing Middle America geographically, historically, and culturally with the broader Latin-American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied in this course. I or II; 1 unit. Prerequisite: Anthropology 102 and 103, or 107, or consent of instructor. WOLF.

362. **Patterns of Folk and Peasant Cultures.** An analysis of the development of folk and peasant cultures in various parts of the world. Data drawn from archaeological and historical records as well as from contemporary ethnological studies. II, ½ unit. Prerequisite: Anthropology 102 and 103, or 107, or consent of instructor. WOLF.

363. **Religion in Primitive Society.** An introduction to the study of magic and religion in nonliterate societies; the course will consider theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. II; 1 unit. Prerequisite: Anthropology 102 and 103, or 107, or consent of instructor. LEWIS.

364. **Field Work in Cultural Anthropology.** Supervised participation in field research; technique and procedures discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice for this course if the area or problems involved are different. Prerequisite: Anthropology 102 and 103, or 107; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor.

365. **Analysis of Field Data in Cultural Anthropology.** Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice for this course if the area or problems involved are different. Prerequisite: Anthropology 102 and 103, or 107; speaking knowledge of the language of the area concerned; consent of instructor.

366. **The Ethnology of South Asia.** An anthropological analysis of the cultures of India and the Greater Indian Culture Sphere (primarily Southeastern Asia). I, II; 1 unit. Prerequisite: Anthropology 107, Sociology 104, or consent of instructor.

367. **Cultures of Native Africa.** A survey of the native cultures of Africa with particular emphasis on the development of culture types and the patterns of behavior associated with them. I, II; 1 unit. Prerequisite: Anthropology 107, Sociology 104, or consent of instructor.

SPANISH AND ITALIAN

(Including Portuguese)

The Department of Spanish and Italian offers courses leading to the degrees of Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are linguistics, Spanish literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 4.0 for that portion of the work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. However, the department reserves the right to admit students on limited status. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, and consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for an advanced degree in Spanish must acquire a practical command of the language. Some knowledge of Italian or Portuguese

is required. A considerable amount of parallel training in one or more other languages or literatures, such as English, French, German, Greek, or Latin, is indispensable. In any case, some Latin is required of candidates for the degree of Doctor of Philosophy. This requirement is usually met by taking a minimum of one semester of Latin, at any level suggested by the student's preparation, while in residence for the doctor's degree. In very special cases, with the consent of the adviser, Spanish literature and linguistics may be used reversibly as major and one minor. More commonly, however, the minor or minors for a major in Spanish literature or linguistics are chosen from some other language and literature, from anthropology, history, philosophy, or other pertinent subjects.

Candidates for an advanced degree or for a minor in Italian or Portuguese should consult the department. Provisions are made to fit individual cases.

Candidates for the degree of Master of Arts in the Teaching of Spanish must earn four units in Spanish, two units in education, and two units in electives. Requirements are Spanish (middle group courses, one to two units, and graduate courses, two to three units), four units; education, two units, including two of the following: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in Spanish and the electives must be selected with the approval of the adviser. The electives may be in Spanish, in Humanities 301, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the department. No limited status students will be admitted to this program. The adviser for candidates for this degree is Professor Joseph S. Flores, 214 Lincoln Hall.

ASSISTANTSHIPS

A limited number of teaching assistantships are available. Application may be made to the Head of the Department.

GRADUATE TEACHING FACULTY

Professors: J. Van Horne (Head of Department), H. R. Kahane, R. P. Oliver.
Associate Professors: J. H. D. Allen, J. S. Flores, Angelina R. Pietrangeli.
Instructors: F. P. Ellison, Harriet Hutter.

Spanish

COURSES FOR GRADUATES

405. **Introduction to Critical Method.** I; ¼ unit. Oliver.

411. **Spanish Literature in the Middle Ages.** I; 1 unit. Offered in 1954-1955 and in alternate years. Allen.

412. **Spanish Literature in the Middle Ages.** II; 1 unit. Offered in 1954-1955 and in alternate years. Allen.

413. **Contemporary Literature.** Twentieth century writing in Spain and Spanish America. I; 1 unit. Van Horne.

414. **Contemporary Literature.** Twentieth century writing in Spain and Spanish America. II; 1 unit. Van Horne.

415. **Spanish Literature in the Sixteenth Century.** I; 1 unit. Offered in 1955-1956 and in alternate years. Oliver.

416. **Spanish Literature in the Sixteenth Century.** II; 1 unit. Offered in 1955-1956 and in alternate years. Oliver.

417. **Seventeenth Century Literature.** I; 1 unit. Offered in 1954-1955 and in alternate years. Flores.

418. **Seventeenth Century Literature.** II; 1 unit. Offered in 1954-1955 and in alternate years. Flores.

419. **Spanish Literature of the Golden Age.** Special problems in the literature of the Golden Age. S; 1 unit. KAHANE.

421. **Modern Spanish and Spanish-American Novel.** I; 1 unit. Offered in 1955-1956 and in alternate years. PIETRANGELI.

422. **Modern Spanish and Spanish-American Novel.** II; 1 unit. Offered in 1955-1956 and in alternate years. PIETRANGELI.

431. **Spanish-American Literature, I: Mexico and Central America.** I; 1 unit. Offered in 1955-1956 and in alternate years. VAN HORNE.

432. **Spanish-American Literature, II: Colombia and the Caribbean.** II; 1 unit. Offered in 1955-1956 and in alternate years. VAN HORNE.

433. **Spanish-American Literature, III: The Pacific Coast of South America.** I; 1 unit. Offered in 1954-1955 and in alternate years. VAN HORNE.

434. **Spanish-American Literature, IV: The Río de la Plata Region.** II; 1 unit. Offered in 1954-1955 and in alternate years. VAN HORNE.

441. **Seminar in the Science of Literature.** The application of recent methods of literary science to Spanish literature. S; 1 unit. KAHANE.

451. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. I; 1 unit. Offered in 1954-1955 and in alternate years. KAHANE.

452. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. II; 1 unit. Offered in 1954-1955 and in alternate years.

453. **Old Spanish.** I; 1 unit. Offered in 1955-1956 and in alternate years. KAHANE.

454. **Old Spanish.** II; 1 unit. Offered in 1955-1956 and in alternate years. KAHANE.

491. **Seminar (Thesis Course).** Research in special topics. I; 1 to 4 units. KAHANE, OLIVER, VAN HORNE.

492. **Seminar (Thesis Course).** Research in special topics. II; 1 to 4 units. KAHANE, OLIVER, VAN HORNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Survey of Spanish Literature.** I; ½ unit. Prerequisite: Spanish 202 or equivalent.

302. **Survey of Spanish Literature.** II; ½ unit. Prerequisite: Spanish 202 or equivalent.

303. **Survey of Latin-American Literature.** I; ½ unit. Prerequisite: Spanish 202 or equivalent. ELLISON.

304. **Survey of Latin-American Literature.** II; ½ unit. Prerequisite: Spanish 202 or equivalent. ELLISON.

311. **Cervantes: Don Quixote.** I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Spanish 202 or equivalent. HUTTER.

312. **Cervantes: Don Quixote.** II; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Spanish 202 or equivalent. HUTTER.

313. **Classical Spanish Drama.** I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Spanish 202 or equivalent. OLIVER.

314. **Classical Spanish Drama.** II; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Spanish 202 or equivalent. OLIVER.

321. **Modern Spanish and Spanish-American Drama.** I; ½ unit. Prerequisite: Spanish 202 or equivalent. PIETRANGELI.

322. **Modern Spanish and Spanish-American Drama.** II; ½ unit. Prerequisite: Spanish 202 or equivalent. PIETRANGELI.

323. Modern Spanish and Spanish-American Novel. Nineteenth and twentieth century novels of Spain. I; ½ unit. Prerequisite: Spanish 202 or equivalent.

324. Modern Spanish and Spanish-American Novel. Nineteenth and twentieth century novels of Spanish America. II; ½ unit. Prerequisite: Spanish 202 or equivalent.

331. La Cultura Hispánica: España. I; ½ unit. VAN HORNE.

351. Phonetics. I; ½ unit. Required for teacher-training majors in Spanish. Prerequisite: Spanish 202 or equivalent. FLORES.

352. Syntax. II; ½ unit. Required for teacher-training majors in Spanish. Prerequisite: Spanish 202 or equivalent. KAHANE.

371. Spanish for Teachers. A consideration of language problems suggested by teaching experience. S; ½ unit. VAN HORNE.

Italian

COURSES FOR GRADUATES

411. Italian Literature in the Middle Ages: Petrarch and Boccaccio. I; 1 unit. Offered in 1954-1955 and in alternate years. OLIVER.

412. Italian Literature in the Middle Ages: Petrarch and Boccaccio. II; 1 unit. Offered in 1954-1955 and in alternate years. OLIVER.

415. Italian Literature of the Renaissance. I; 1 unit. Offered in 1955-1956 and in alternate years. OLIVER.

416. Italian Literature of the Renaissance. II; 1 unit. Offered in 1955-1956 and in alternate years. OLIVER.

451. Seminar in Italian Linguistics. I; 1 unit. KAHANE.

452. Seminar in Italian Linguistics. II; 1 unit. KAHANE.

491. Seminar (Thesis Course). Research in special topics. I; 1 to 4 units. KAHANE, OLIVER, VAN HORNE.

492. Seminar (Thesis Course). Research in special topics. II; 1 to 4 units. KAHANE, OLIVER, VAN HORNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Dante: La Divina Commedia. I; ½ unit. Prerequisite: Italian 101 and 102. Italian 103 and 104 are optional, but desirable. PIETRANGELI.

312. Dante: La Divina Commedia. Continuation of Italian 311. II; ½ unit. Prerequisite: Italian 101 and 102. Italian 103 and 104 are optional, but desirable. PIETRANGELI.

321. Modern Italian Literature. I; ½ unit. Prerequisite: Italian 101 and 102. Italian 103 and 104 are optional, but desirable. VAN HORNE.

322. Modern Italian Literature. II; ½ unit. Prerequisite: Italian 101 and 102. Italian 103 and 104 are optional, but desirable. VAN HORNE.

Portuguese

COURSES FOR GRADUATES

491. Seminar (Thesis Course). Research in special topics. I; 1 to 4 units. ALLEN, KAHANE.

492. Seminar (Thesis Course). Research in special topics. II; 1 to 4 units. ALLEN, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Brazilian Literature.** Survey of the contemporary Brazilian novel. I; ½ unit. Prerequisite: Portuguese 101 and 102. Portuguese 103 and 104 are optional, but desirable. ALLEN.

302. **Introduction to Portuguese Literature.** Survey of the Golden Age of Portuguese. II; ½ unit. Prerequisite: Portuguese 101 and 102. Portuguese 103 and 104 are optional, but desirable. ALLEN.

SPEECH

The Department of Speech offers courses leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy.

The admission requirement, in terms of grade-point average, is at least 3.5 for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are admitted on limited status except in the special curricula in the teaching of speech and in speech correction.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theater, oral interpretation, speech science, speech and hearing disorders. They may also select a special curriculum in the teaching of speech.

For the degree of Master of Science, students may take a special curriculum in speech correction.

For the degree of Doctor of Philosophy, students may exercise one of three options: rhetoric and public address; the theater; speech science, speech and hearing disorders.

In addition to the general regulations of the Graduate College with respect to entrance, distribution of credits, examinations, and theses, the Department of Speech specifies the requirements listed below.

Degree of Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech. If he does not present sixteen hours of credit in speech, he must make up the deficiency before he can be regarded as a candidate for a graduate degree. His record should include these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theater, and an advanced course in public speaking or discussion.

In consultation with the Head of the Department, the candidate chooses an adviser with whom he should confer about all details of his program.

A normal program of study requires eight graduate units (four each semester) for graduation. The student with a well-rounded undergraduate education may take all eight units in speech; other students are expected to declare a major in speech (to consist of at least four units) and one or two minors in related fields of study outside the department. As a rule, a minor will not exceed two units.

Whether or not a thesis is presented depends upon the candidate's educational and professional aims. After consultation with the student, the student's adviser and the Head of the Department will decide in each case whether a thesis should be submitted as part of the degree requirements. Students who expect to go on to a doctor's degree will as a rule be required to present a thesis.

A final, written examination will be required of all candidates. In some cases an oral examination is also stipulated. The examination covers in part the general field in speech and in part the candidate's area of specialization.

Although no reading knowledge of a foreign language is required for the master's degree, students who expect to do further graduate study should become familiar with the language requirements for the doctor's degree.

Degree of Master of Arts in the Teaching of Speech. Candidates for the Master of Arts degree who are interested in public school teaching should meet the following requirements:

(1) In the area of rhetoric and public address: speech, three units, including Speech 322 and 423, and one and one-half units chosen from 311, 312, and 321; education, two units, including two of the following: Education 301, 302, 303, 304, one unit, and Education 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of the theater: speech, four units, including Speech 361 or 362 or 366, 352, 451, 452; education, two units, including two of the following: Education 301, 302, 303, 304, one unit, and Education 311 and 312, one unit; electives, two units.

Degree of Master of Science in Speech Correction. This program is designed for teachers who have completed a Bachelor of Science in Speech Correction at the University of Illinois or its equivalent at a recognized college or university, and who desire to obtain an advanced degree in speech correction.

The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all of the requirements of a four-year undergraduate curriculum but who desire to take the fifth year of work for a master's degree may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 383, 387, 475, 476, 481, 483, 486, 488, 489, 493, 494; two units of education, one unit from Education 301, 302, 303, 304, and one unit from Education 311 and 312; two units of electives. The electives may be in speech, in education, in psychology, or, in exceptional cases, in other fields.

Degree of Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree from an accredited institution. In consultation with the Head of the Department, the doctoral candidate, like the master's candidate, secures a departmental adviser.

For the student not holding an advanced degree, twenty-four graduate units are required; for the student who holds an advanced degree, sixteen graduate units must be completed. Although the majority of the units are taken within the department, each candidate must choose at least one minor subject outside the department to consist of not less than four units. The candidate may choose two minor subjects, and in that case the second minor consists of not less than two units. If two minors are selected, one must be closely related to the student's area of emphasis. With the approval of the adviser and the Dean of the Graduate College, the second minor may represent a division of the major field of study.

All candidates for the doctor's degree are required to present a thesis which will count for no more than eight graduate units.

At the end of the second year of graduate study, the candidate must pass a preliminary examination. This examination is written; it covers the student's area of specialization and the areas of knowledge represented by the candidate's graduate program. The final examination, after completion of the thesis, is oral and is for the most part restricted to the research represented by the thesis.

A reading knowledge of two foreign languages, German and usually French, is required of all candidates. The examination in both languages must have been passed satisfactorily before the preliminary examination may be taken.

GRADUATE TEACHING FACULTY

Professors: K. R. Wallace (Head of Department), G. Fairbanks, B. Hewitt, R. Murphy, Severina E. Nelson, W. M. Parrish.

Associate Professors: E. T. Curry, O. A. Dieter, H. E. Gulley, M. T. Herrick, Marie K. Hochmuth, L. S. Hultzén, J. C. Kelly, H. O. Kubly, C. H. Shattuck, W. Swanson, K. A. Windesheim.
Assistant Professors: Clara M. Behringer, K. Burns, Patricia McIlrath, H. L. Mueller, R. E. Nadeau, J. W. Scott.

COURSES FOR GRADUATES

403. **Seminar in Problems of Speech Instruction.** Investigation of current philosophies, methods, and materials as they relate to effective instruction in the various areas of speech. I; 1 unit. Burns.

411. **Greek Rhetoric and Oratory, 500 to 300 B.C.** Study of rhetorical theories and selected speeches available in English, and correlation of theory and practice. Early development of the art of rhetoric; relation of rhetorical theories to practice as exemplified in selected speeches. I; 1 unit. Nadeau.

412. **Roman Rhetoric and Oratory.** Study of Roman rhetorical theory and practice from Hermagoras to Quintillian (ca. 100 B.C. to 200 A.D.). II; 1 unit. Dieter.

423. **The Rhetoric of Aristotle.** Study of the *Rhetoric* in relation to other works of Aristotle. I; 1 unit. Wallace.

424. **Medieval and Renaissance Rhetoric and Oratory.** Study of rhetorical theory and practice in medieval and Renaissance times. II; 1 unit. Dieter.

436. **Seminar in Public Discussion.** Investigation of special problems in public discussion. II; 1 unit. Prerequisite: Speech 213. Murphy.

438. **Seminar in Rhetorical Theory.** Study of special topics in the history of rhetorical theory. II; 1 unit. Prerequisite: At least one graduate course in rhetoric and oratory. Wallace.

441. **Principles and Theories of Oral Interpretation.** Historical survey of British and American theories of interpretation. I; 1 unit. Parrish.

442. **Seminar in Oral Interpretation.** Investigation of basic problems in the history, nature, and function of oral interpretation. II; 1 unit. Prerequisite: Speech 441; consent of instructor. Parrish.

451. **Problems in Play Directing in the School Theater.** Study of the audience, play selection, the actor's abilities and needs, try-outs and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. I; 1 unit. Swanson.

452. **Problems in Play Production in the School Theater.** Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. II; 1 unit. Swanson.

461. **Advanced Theater Techniques.** Individual development of advanced techniques of acting and staging through supervised participation in public productions. S; ½ to 1 unit. Prerequisite: At least one semester of graduate study in the area of theater; consent of head of the department and instructor. Behringer.

463. **Seminar in the History of Acting.** Studies in the history and theory of the art of acting. II; 1 unit (students may accumulate 2 units). Shattuck.

465. **Seminar in Theater Art.** Studies in the aesthetics of the theater. I; 1 to 2 units. Hewitt.

468. **Seminar in Theater History.** Studies in the history of the theater. II; 1 to 2 units. Hewitt.

471. **Electroacoustics of Speech.** The application of acoustical and electrical principles to the analysis of speech. Lectures, demonstrations, and laboratory work. I or II; 1 unit. Prerequisite: Speech 375 and 376. Curry.

472. **Psychoacoustics of Speech.** Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. II; 1 unit. Prerequisite: Consent of instructor. CURRY.

473. **Seminar in Phonetics.** Advanced study in phonetic theory, noninstrumental phonetics, linguistic geography. I or II; 1 unit. Prerequisite: Consent of instructor. HULTZÉN.

475. **Experimental Phonetics, I.** Principles of experimental investigation of the physiological aspects of speech and hearing; survey of the theoretical and experimental literature. Demonstration and experimental work in the speech laboratory. I; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

476. **Experimental Phonetics, II.** Principles of experimental investigation of the acoustical and psychophysical aspects of speech and hearing; survey of the theoretical and experimental literature. Demonstration and experimental work in the speech laboratory. II; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

477. **Measurement of Speech, I.** Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. I; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. FAIRBANKS.

478. **Measurement of Speech, II.** Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. II; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. FAIRBANKS.

479. **Seminar in Experimental Phonetics.** Advanced consideration of experimental research in the physiological, acoustical, and psychophysical aspects of speech and hearing. Extensive survey of current literature. S; 1 unit. Prerequisite: Speech 475 and 476, or consent of instructor. FAIRBANKS.

481. **Seminar in Voice and Articulation Disorders.** Advanced study of voice and articulation disorders; survey of research and theory; principles of therapy. I or II; 1 unit. Prerequisite: Consent of instructor. KELLY.

483. **Seminar in Psychology of Speech Disorders.** Advanced theoretical study of psychological disorders of speech such as stuttering, delayed speech, and hysterical conditions; survey of current theory and research. I or II; 1 unit. Prerequisite: Consent of instructor.

486. **Advanced Clinical Techniques in Speech and Hearing.** Practice of advanced clinical therapy for speech and hearing disorders; semi-independent management of complex difficult cases; participation in examination and analysis. I, II; 1 to 4 units. Prerequisite: Consent of instructor. CURRY, NELSON.

488. **Diagnosis of Speech Disorders.** Study of diagnostic procedures used in analysis of symptoms involved in speech disorders. II; 1 unit. NELSON.

489. **Seminar in Organic Speech Disorders.** Principles and methods of clinical and classroom correction of speech disorders associated with organic dysfunctions. I or II; 1 unit. Prerequisite: Consent of instructor. NELSON.

493. **Research in Special Topics.** I, II; 1 to 4 units. CURRY, DIETER, FAIRBANKS, GULLEY, HEWITT, HOCHMUTH, HULTZÉN, KELLY, MURPHY, NELSON, PARRISH, SHATTUCK, SWANSON, WALLACE, WINDESHEIM.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Phonetics.** Basic principles of phonetic study, including ob-

servation and representation of pronunciation; ear training; practice in transcription. I, II; ½ to 1 unit. HULTZÉN, MUELLER, PARRISH.

311. **British Public Address.** Study of representative British speakers from the sixteenth century to the present. Lectures, reports, and papers. I; ½ to 1 unit. Prerequisite: Speech 117 or 221. MURPHY.

312. **American Public Address.** Study of representative American speeches from the sixteenth century to the present. II; ½ to 1 unit. Prerequisite: Speech 117 or 221. HOCHMUTH.

321. **Modern Rhetorical Theory, 1700 to 1890.** A consideration of the significant movements in the development of rhetorical theory in England, France, and America from 1700 to 1890. I; ½ to 1 unit. HOCHMUTH.

322. **Modern Rhetorical Theory, 1890 to the Present.** A consideration of the significant movements in the development of rhetorical theory in England, France, and America from 1890 to the present. II; ½ to 1 unit. HOCHMUTH.

327. **Discussion and Debate for High School Teachers.** Study of discussion and debate techniques, with special emphasis on curricular and co-curricular programs in the high school and on recent forms and procedures. S; ½ unit. Prerequisite: Consent of instructor. GULLEY.

342. **Advanced Oral Interpretation.** Oral interpretation of poetry. I, II; ½ to 1 unit. Prerequisite: Speech 141. MCILRATH, PARRISH.

352. **Theories of Play Production.** Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theater architecture, acting, directing, and staging. I; ½ to 1 unit. SWANSON.

353. **Creative Dramatics for Children.** A study of the subject matter and techniques of creative dramatics for children, with laboratory application. S; ½ to 1 unit. Prerequisite: Consent of instructor.

354. **Theater for the Child Audience.** A study of the history, the objectives, and the techniques of play production for the child audience, with laboratory application. S; ½ to 1 unit. Prerequisite: Consent of instructor.

361. **History of the European Theater to the Renaissance.** The theater and the theater arts of ancient and of medieval Europe. I; ½ to 1 unit. SCOTT.

362. **History of the European Theater from the Renaissance to 1900.** The European theater and the theater arts from 1576 to 1900, with special reference to the English theater. II; ½ to 1 unit. SCOTT.

363. **Advanced Playwriting.** Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing the full-length play. I, II; ½ to 1 unit (students may accumulate 2 units). Prerequisite: Speech 263; consent of instructor.

366. **Development of the American Theater.** The development of the theater and theater arts in America from colonial times to the beginning of the twentieth century. I, II; ½ to 1 unit. HEWITT.

370. **Stage Scenery Design.** Theory and practice of designing stage scenery. II; ½ to 1 unit. Prerequisite: Speech 157 and two of the following: Speech 255, 352, 361, 362; or consent of instructor. SCOTT.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as English 371. I; ½ to 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as English 372. II; ½ to 1 unit. HERRICK.

373. **Phonetics and Phonemics.** Methodologies of phonetics, with special application to English; general principles of phonemic interpretation. I or II; ½ to 1 unit. Prerequisite: Speech 301. HULTZÉN.

375. **Speech Science.** Introduction to anatomical and physiological characteristics of the normal speech mechanism. Demonstration in the speech laboratory. I, II; ½ unit. Prerequisite: Consent of instructor. CURRY.

376. **Speech Science.** Introduction to the acoustical characteristics of voice and speech sounds and to the physiology of the ear. Demonstration in the speech laboratory. II; ½ unit. Prerequisite: Consent of instructor. CURRY.

383. **Psychological Disorders of Speech.** Principles and methods of clinical and classroom correction of psychological disorders of speech, with special reference to stuttering and delayed speech; clinical and classroom practice with children and adults. I or II; 1 unit. Prerequisite: Consent of instructor.

385. **Speech Correction.** Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation and practice in clinical techniques are provided in the laboratory. I; ½ to 1 unit. Prerequisite: Ten hours of speech or consent of instructor. NELSON.

386. **Speech Clinical Practice, I.** Case work and practice teaching in remedial speech (see Educational Practice 220, Section B). I; ½ unit. NELSON and staff.

387. **Voice and Articulation Disorders.** Principles and methods of clinical and classroom correction of voice and articulation disorders. I, II; ½ unit. Prerequisite: Speech 385; consent of instructor. KELLY.

388. **Speech Correction.** Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and glandular disorders. II; ½ unit. Prerequisite: Speech 385. NELSON.

389. **Speech Clinical Practice, II.** Case work and practice teaching in remedial speech (see Educational Practice 220, Section C). II; ½ unit. NELSON and staff.

391. **Introduction to Hearing Disorders.** Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. I or II; ½ unit. Prerequisite: Ten hours of speech; Speech 301; consent of instructor. CURRY.

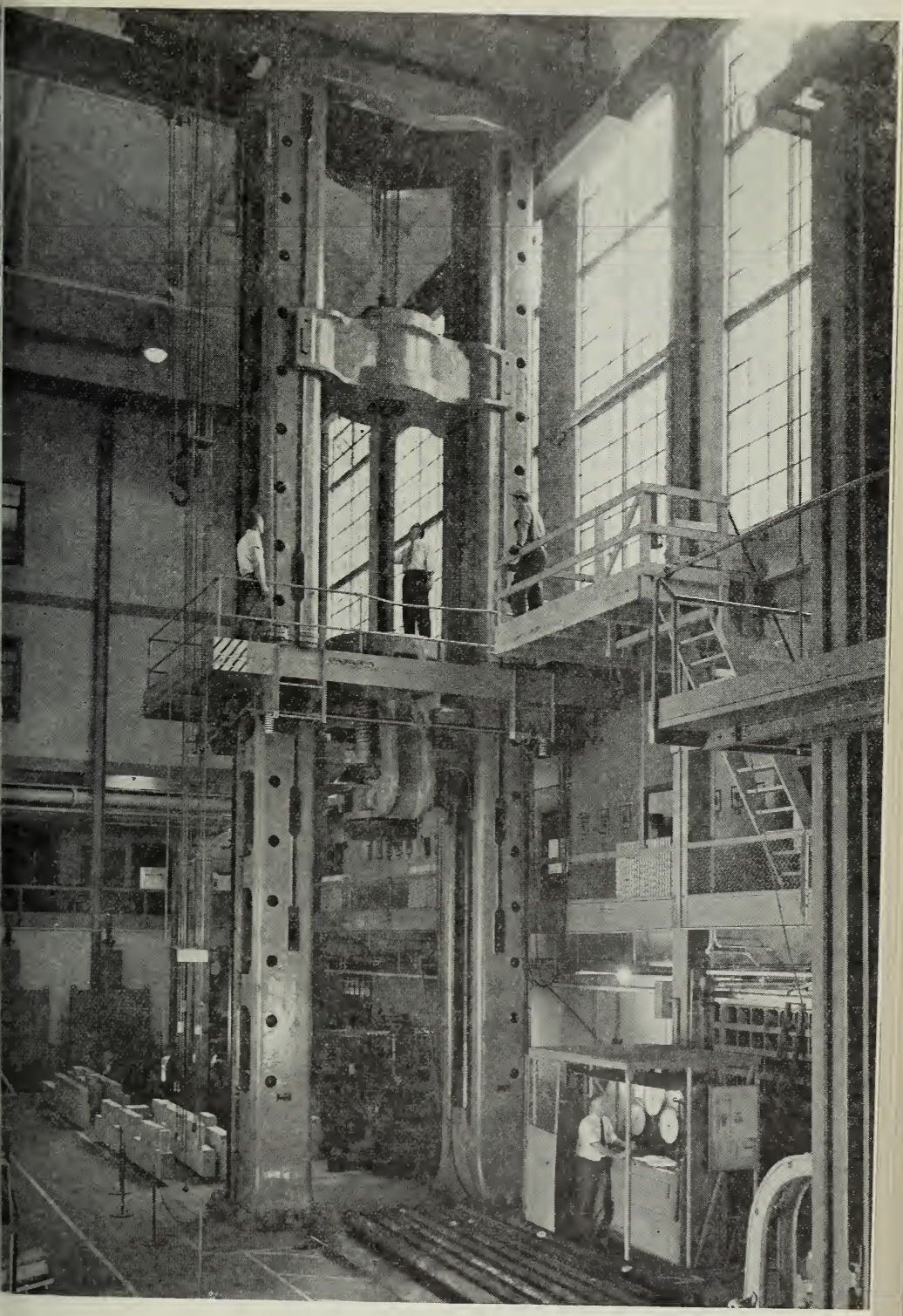
393. **Aural Rehabilitation.** Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling; clinical and classroom practice with children and adults. I, II; ½ unit. Prerequisite: Speech 391; consent of instructor. Required in the curriculum of teacher training in speech correction.

395. **Audiometry and the Use of Hearing Aids.** Selective and diagnostic tests of hearing, the planning and conduct of hearing conservation programs, general problems involved in the use of hearing aids. I, II; ½ unit. Prerequisite: Speech 376. CURRY.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers graduate work in the field of engineering, leading to the degree of Master of Science in Theoretical and Applied Mechanics and Doctor of Philosophy in Theoretical and Applied Mechanics.

In the program for graduate study emphasis is placed on both course work and research, the latter being either analytical or experimental. As the name of the department implies, the research is both "theoretical" and "applied" and may be divided into two general classifications, that financed by departmental funds



,000,000-lb. testing machine used by students engaged in research on behavior of structural materials under a tensile or a compressive load.

and carried on primarily by the teaching staff and second, the cooperative investigations financed by industry, industrial organizations, or governmental agencies. The department, as part of the Engineering Experiment Station, actively conducts many research investigations and makes studies of importance to the engineering, manufacturing, and other industrial interests as well as to various governmental agencies. Some of the fields of greatest research activity are properties of materials and the elastic and inelastic behavior of load-resisting members; fatigue of metals; properties and behavior of plain concrete, reinforced concrete beams, columns, footings, slabs and frames; creep of lead and of plastics and other inelastic behavior of materials; hydraulics and fluid mechanics; stresses in railway car wheels, rails, and bolted and welded rail joints; mechanical vibrations of machines and structures and vibration damping; photoelastic, electric strain gage, and other methods of experimental stress analysis; constant humidity and temperature investigations of plastics; materials subjected to static and dynamic loads; theoretical analyses of problems in fluid flow, dynamics, theory of elasticity, and theory of plasticity.

Graduate students electing theoretical and applied mechanics as their major must have had the equivalent of the undergraduate courses in mechanics required for a bachelor's degree in any of the curricula in the College of Engineering. Students applying for admission must have a 3.5 grade-point average for that portion of the work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students on limited status are not admitted. Students taking the Doctor of Philosophy degree are required to take, in addition to thesis, at least one-half unit from each of the following three groups: (1) Theoretical and Applied Mechanics 321, 323, 326, 421, 422, 424, 427, 451, 452, 461, 462, 464; (2) Theoretical and Applied Mechanics 311, 412, 416; (3) Theoretical and Applied Mechanics 334, 431, 432, 436. The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science degree is one unit; for the Doctor of Philosophy degree, the requirement for a first minor is four units, and for a second minor, two units.

ASSISTANTSHIPS

Part-time assistantships in teaching and research are available. The general qualification is a high scholastic record. Applications for assistantships in teaching or research should be addressed to the Head of the Department.

GRADUATE TEACHING FACULTY

Professors: T. J. Dolan (Head of Department), W. E. Black, W. L. Collins, A. M. Freudenthal (Research Consultant), P. G. Jones, H. L. Langhaar, W. M. Lansford, W. J. Putnam, H. J. Schrader, W. L. Schwalbe, J. O. Smith.

Associate Professors: C. E. Bowman, C. E. Kesler, O. M. Sidebottom, M. C. Steele.

Assistant Professors: M. Stippes, I. M. Viest.

COURSES FOR GRADUATES

412. **Vibration Analysis.** A continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's method; iteration process and matrix procedure; vibrations in

reciprocating machines, airplane structures, and propellers; impact and transient vibrations; self-excited vibration; stability; non-linear systems. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 311. JONES.

416. **Energy Methods in Mechanics of Materials.** The principle of virtual work and the related principles of minimum potential energy, least work, and complementary energy, with applications to problems of equilibrium and stability of frames, curved beams, rings, plates and shells. I; 1 unit. LANGHAAR.

421. **Mechanics of Materials.** Methods of obtaining relations between loads and stresses and strains in various members. The main topics covered in this course and in course 422 are curved beams, unsymmetrical bending, thick-walled cylinders, beams on elastic supports, contact stresses, torsion of members with non-circular cross-section, stress concentrations, elastic energy methods applied to statically indeterminate members, flat plates, inelastic behavior of various types of members. Introduction to mathematical theory of elasticity; elastic and plastic buckling; criteria of failure by yielding and by fracture. I; ½ to 1 unit. BLACK, SMITH.

422. **Mechanics of Materials.** Continuation of Theoretical and Applied Mechanics 421. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 421. BLACK, SMITH.

424. **Properties of Engineering Materials.** Significance of properties under various conditions of loading and use, including static, creep and fatigue, and impact properties; tests and interpretation of test data; methods of obtaining special combinations of properties; effects of temperature, strain rate, internal structure, etc.; specifications of properties and materials. II; ½ to 1 unit. COLLINS.

427. **Theories of Mechanical Properties and Behavior of Plain Concrete.** Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Specific topics are behavior of plain concrete under different types of loading, such as long time and repeated; behavior of plain concrete subjected to uni-, bi-, and tri-axial states of stress. The studies involve critical reviews of experimental and analytical investigations. I; ½ to 1 unit. KESLER.

431. **Theory of Flow of Incompressible Fluids.** A course emphasizing topics in theoretical fluid mechanics that are the basis of many modern developments. The material consists of an introduction to Gibbs' vector analysis, fundamentals of frictionless flow, Euler's differential equations of motion, velocity potentials, stream functions, sources and sinks, solution of axially symmetrical flow problems, and elements of complex variable theory with applications to plane flow. I; 1 unit. ROBERTSON.

432. **Theory of Flow of Incompressible Fluids.** Continuation of Theoretical and Applied Mechanics 431. Conformal mapping, Blasius' theorems of lift and moments, vortex motion. Helmholtz's theory of line vortexes and vortex sheets. Biot-Savart theorem for determining the velocity field induced by line vortexes, stresses in viscous fluids, Navier-Stokes equations, elementary solutions of viscous flow problems, elements of the hydrodynamic theory of lubrication, and differential equations of the laminar boundary layer. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 431 or equivalent. ROBERTSON.

436. **Dimensional Analysis and Theory of Models.** A course developing the basic methods of dimensional analysis, with applications to the theory of models and the planning of experiments. An integrated picture of important applications in various fields of engineering and a broad understanding of the uses and limitations of the subject are presented. Specific topics are selected

from the following: nature and use of dimensions; principles of dimensional analysis; systematic calculation of dimensionless products; algebraic theory of dimensional analysis; similarity and model laws; differential equations and similarity; dimensional analysis applied to problems of stress and strain, fluid mechanics, theory of heat, and electrical engineering. II; ¾ unit. LANGHAAR.

451. **Theory of Elasticity with Application to Engineering Problems.** A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. I; 1 unit. LANGHAAR.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. LANGHAAR.

461. **Inelastic Behavior of Engineering Materials (Theory of Plasticity).** An outline of a general theory of inelastic behavior involving the relations between loads and stresses and strains in various members that are stressed beyond the elastic range. The cases considered include those in which the inelastic actions involve bodies which are made of materials that behave ideally viscous, ideally plastic, and combinations of the two. Some specific topics are mechanisms of inelastic action of members in which the stresses and strains are essentially uni-axial, such as straight beams, curved beams, and members subjected to combined axial and bending loads; deflection of beams; statically indeterminate members loaded inelastically; inelastic buckling; "shake down" of simple statically indeterminate members; etc. I; ½ to 1 unit. SMITH.

462. **Inelastic Behavior of Engineering Materials (Theory of Plasticity).** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading functions. This course deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. SMITH, STEELE.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. II; ½ to 1 unit. LANGHAAR.

491. **Thesis (Master's).** I, II; ½ to 2½ units. STAFF.

492. **Thesis (Doctor's).** I, II; 1 to 4 units. STAFF.

493. **Advanced Independent Study (Special Problems).** Individual investigation of studies, either analytical or experimental, in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Mechanical Vibrations.** Kinematics of vibratory motion; comprehensive

study of vibrating systems having a single degree of freedom. Specific topics are natural frequencies in undamped vibration and the energy (Rayleigh) method; viscous, Coulomb, and solid (hysteresis) damping; forced vibration; work done by harmonic forces; method of complex algebra; critical speeds and balancing; balancing machines; vibration isolation; vibration instruments. For systems with several degrees of freedom, specific topics are modes; coupled vibrations; vibration absorbers and dampers; vehicle suspension; Holzer's analysis for torsional systems. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 154 or 156, or 211 and 221. JONES.

321. **Advanced Mechanics of Materials.** Methods used in elementary mechanics of materials are expanded and generalized and used to solve more complex problems. Thick-walled cylinders, torsion of bar having non-circular cross-section; curved beams, unsymmetrical bending, flat plates; theories of failure. Use of energy methods for determining deflections and for solving statically indeterminate problems. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. BLACK, SIDEBOTTOM, SMITH.

323. **Advanced Laboratory in Materials Testing.** Calibration of testing machines and of strain measuring instruments. Use of various mechanical and electrical strain gages; determination of the mechanical properties of five different materials under various types of tests — tension, compression, torsion, flexure, impact, and hardness; interpretation of test results. Relation of tests to specifications of materials. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. COLLINS, PUTNAM.

326. **Experimental Stress Analysis.** Methods of extending and applying basic physical laws to the measurement of stresses or deformations that are of significance in the engineering design of load resisting members. Systematic applications of optical, electrical, and physical properties of matter to the instrumentation and measurement of model or prototype stresses. Among the topics studied are photoelasticity, significant mechanical characteristics of materials, accuracy vs. sensitivity of measurement, dynamometers, and strain measuring devices, measurement of vibration stresses, models and analogies, brittle coatings, electrical resistance gages, etc. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223; 321 desirable. BOWMAN.

334. **Fluid Mechanics and Advanced Hydraulics.** A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. LANSFORD.

VETERINARY PATHOLOGY AND HYGIENE

Graduate students who choose veterinary pathology and hygiene as a major nust be graduates of a recognized veterinary college. Students applying for ıdmission must have a grade-point average of at least 3.5 for that portion of the vork which represents the last fifty per cent of the hours completed to secure the ›achelor's degree, exclusive of required physical education and military training. n certain cases graduate students may be accepted on limited status. Students vhose major is in a related field may register for a minor in veterinary pathology nd hygiene.

The Master of Science and Doctor of Philosophy degrees are offered in eterinary pathology and hygiene. Candidates for the master's degree must pass a

reading knowledge examination in one foreign language in addition to satisfying the other requirements of the Graduate College for this degree.

ASSISTANTSHIPS

Teaching and research assistantships are available for selected graduate students. Applications for assistantships should be directed to the Dean of the College of Veterinary Medicine.

GRADUATE TEACHING FACULTY

Professors: J. O. Alberts (Head of Department), P. D. Beamer, L. E. Boley, R. Graham, N. D. Levine, C. C. Morrill, L. E. St. Clair, J. Sampson.
Associate Professors: H. S. Bryan, R. P. Link.
Assistant Professor: E. F. Reber.

COURSES FOR GRADUATES

401. **Laboratory Diagnostic Methods in Veterinary Bacteriology.** Diagnosis of the animal diseases caused by bacteria, filtrable viruses, and fungi. I; 1 unit. Prerequisite: Bacteriology 326 or equivalent. Alberts.

402. **Laboratory Diagnostic Methods in Veterinary Parasitology.** Diagnosis, cultivation, chemotherapy, and host-parasite relations of protozoan, helminth, arthropod, and fungal parasites of domestic animals. II; ½ to 1 unit. Prerequisite: Veterinary Pathology and Hygiene 324 or Zoology 318 and 321 or equivalent; Chemistry 133 or equivalent. Levine.

404. **Seminar.** Required of all graduate students whose major is veterinary pathology and hygiene. I, II; ¼ unit. Graham, Levine.

405. **Advanced Veterinary Pathology.** Advanced study of gross and microscopic pathology of diseases of domestic animals. I; 1 unit. Morrill.

406. **The Experimental Method in Veterinary Research.** Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. Lectures and discussion. I; ¼ unit. Levine.

493. **Research.** Assigned problems of research in veterinary pathology, histology, physiology, parasitology, and bacteriology. I, II; ½ to 4 units. Alberts, Beamer, Boley, Bryan, Graham, Levine, Link, Morrill, Reber, St. Clair, Sampson.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

325. **General Pathology.** The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasms. Lectures, quizzes, demonstrations, and laboratory. II; 1 unit. Prerequisite: Second-year standing in veterinary curriculum or consent of instructor. Morrill.

332. **Principles of Sanitation in the Processing and Handling of Foods.** Same as Food Technology 332. A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and microorganisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods. Government and public health regulations. Local field trips to food processing plants. II; ½ unit. Prerequisite: Bacteriology 104 and 105, Chemistry 132, or equivalents. Ordal.

ZOOLOGY

The Department of Zoology offers work leading to the degrees of Master of Science and Doctor of Philosophy.

Graduate students who choose zoology as a major must have had at least two years of undergraduate work in zoology. However, under special circumstances, advanced courses in closely allied subjects may be accepted in place of the fourth semester of zoology. Students applying for admission must have a 3.75 grade-point average for that portion of the work which represents the last fifty per cent of the hours earned toward the bachelor's degree, exclusive of required courses in physical education and military training. Students on limited status are not admitted.

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology. Requirements for a minor in zoology are as follows:

Sole Minor: Four units in zoology, at least one of which shall be in work open to graduate students only.

First Minor: Three units in zoology, at least one of which shall be open to graduate students only.

Second Minor: Any two units in zoology offering graduate credit. Students from other departments must have had a strong undergraduate background in zoology.

A reading knowledge of German and French is indispensable for graduate study in zoology, and familiarity with Latin and Greek is of great advantage.

Graduate students whose major is zoology are strongly advised to study at least one summer at a marine biological station. Every candidate for the Doctor of Philosophy degree in zoology must furnish evidence of having completed satisfactorily at least six weeks of work at an approved station before being allowed to take the preliminary examination for the doctorate.

Although no special degree in wildlife management is offered, students may prepare themselves for that type of work by selecting courses from the following list: Zoology 304, 318, 321, 335, 336, 337, 338, 343, 345, 418, 445, 446, and research courses. Such students should choose their minors from botany, physiology, entomology, and bacteriology.

For the degree of Master of Science in the Biological Sciences or in the Teaching of the Biological Sciences and General Science, see page 59.

Special information relating to departmental standards and requirements and chief fields of specialization within the department may be obtained by writing to the Head of the Department, 345 Natural History Building.

ASSISTANTS

A limited number of one-fourth and one-half time graduate teaching assistantships are available in the department. Inquiries concerning such appointments should be directed to the Head of the Department, 345 Natural History Building.

GRADUATE TEACHING FACULTY

Professors: F. B. Adamstone (Head of Department), B. V. Hall, L. Ingle, S. C. Kendeigh, W. M. Luce, S. M. Rose, L. J. Thomas.

Associate Professors: H. I. Fisher, D. F. Hoffmeister, O. E. Kugler, M. R. Matteson, H. H. Shoemaker, H. M. Smith.

Assistant Professors: C. C. Clark, J. O. Corliss, J. B. Kitzmiller, F. J. Kruidenier.

COURSES FOR GRADUATES

403. **Cytology.** Structure and organization of the animal cell. I; 1 unit. Prerequisite: A course including histological technique. ADAMSTONE, CLARK.

404. **Experimental Cytology.** An experimental approach to knowledge of the chemical and physical structure of cells. II; 1 unit. Prerequisite: Zoology 403 or consent of instructor. CLARK.

409. **History of Zoology.** The development of zoological concepts from the classical Greek period to the present. I; ½ to 1 unit. ROSE.

411. **Discussion in Genetics and Cytogenetics.** Same as Botany 411. I, II; ¼ unit. KITZMILLER, LUCE, RHOADES.

418. **Advanced Protozoology.** Detailed morphological, physiological, and developmental studies of human protozoa and certain other important forms; introduction to, and practice of, technique. II; 1 unit. Prerequisite: Zoology 318. CORLISS.

422. **Advanced Helminth Parasitology.** Advanced study of modern methods in helminthology. II; 1 unit. Prerequisite: Zoology 321, Bacteriology 327, or equivalent. THOMAS.

424. **Invertebrate Taxonomy.** Individual problems in taxonomy of invertebrates. II; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Zoology 304. MATTESON.

432. **Classification, Phylogeny, and Evolution of Vertebrates.** I; 1 unit. Offered in 1955-1956 and in alternate years. Prerequisite: Zoology 132. SMITH.

433. **Embryology.** A study of initial differences in developing systems and interactions leading to more complex differences. I; 1 unit. Prerequisite: Zoology 333. ROSE.

435. **Animal Behavior.** Seminar on modern concepts, problems, and methods with special reference to vertebrates under free-living natural conditions. I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Zoology 335, 336, 337, or 338. KENDEIGH.

445. **Advanced Ecology and Wildlife Management.** Seminar on modern techniques, concepts, and problems. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Zoology 345 or equivalent. KENDEIGH.

446. **Physiological Ecology.** Physiological adjustments and responses of organisms to their environment. II; 1 unit. KENDEIGH.

455. **Advanced Genetics.** The gene in heredity, development, and evolution. I; 1 unit. LUCE.

456. **Physiological Genetics.** The nature of the gene and its action in the developmental and physiological processes of the organism. II; 1 unit. LUCE.

462. **Advanced General Physiology.** Same as Physiology 462. Seminar, lectures, student reports, discussions. I or II; ½ unit. Prerequisite: Consent of instructor. PROSSER.

467. **Experimental Embryology.** II; 1 unit. Prerequisite: Zoology 433. ROSE.

493. **Individual Research.** I; ½ to 4 units.

494. **Individual Research.** II; ½ to 4 units.

Work in the following fields is offered for students registered in Zoology 493 or 494:

Ecology and Taxonomy: Ecology, KENDEIGH; Herpetology, SMITH; Ichthyology, SHOEMAKER; Limnology, MATTESON; Mammalogy, HOFFMEISTER; Ornithology, FISHER, KENDEIGH; Wildlife Management, KENDEIGH, SHOEMAKER.

Vertebrate Anatomy: Histology, ADAMSTONE; Vertebrate Anatomy, FISHER, HALL, SMITH.

Invertebrate Zoology: Helminthology, THOMAS; Invertebrate Zoology and Field Zoology, INGLE, MATTESON; Parasitology, KRUIDENIER, THOMAS; Protozoology, CORLISS.

Experimental Zoology: Chemical Embryology, KUGLER; Cytology, ADAMSTONE, CLARK; Embryology and Regeneration, ROSE; Endocrinology, HALL; Genetics and Evolution, KITZMILLER, LUCE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Seminar.** For members of the staff and graduate students. Required of all graduate students but also open to seniors whose major is zoology. I; no credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar.

301. **General Seminar.** For members of the staff and graduate students. Required of all graduate students but also open to seniors whose major is zoology. II; no credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar.

302. **Individual Topics.** For those who wish to study individual problems. Candidates for honors and undergraduates who are enrolled for tutorial work or in individual curricula should register in this course. Graduates may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. I; ½ to 1 unit. Prerequisite: Two years of zoology; approval of department. STAFF.

303. **Individual Topics.** For those who wish to study individual problems. Candidates for honors and undergraduates who are enrolled for tutorial work or in individual curricula should register in this course. Graduates may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. II; ½ to 1 unit. Prerequisite: Two years of zoology; approval of department. STAFF.

304. **Field and Systematic Zoology.** Collection, preservation, and identification of lower vertebrates and fresh water invertebrates; habits and life histories of selected forms. I; 1 unit. Prerequisite: One year of zoology, or equivalent. MATTESON.

306. **Biology for Teachers.** Same as Botany 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. Note: In order to make possible out-of-town practice teaching, this course will be completed during the first six weeks of the semester. II; ¼ or ½ unit. Prerequisite: Botany 100; Zoology 101 or Zoology 104, or a one-year course in general biology. FULLER, MATTESON.

318. **Protozoology.** Morphology, taxonomy, physiology, and life history of representative free-living and parasitic protozoa. I, II; 1 unit. Prerequisite: One year of zoology or equivalent. CORLISS.

320. **Invertebrate Zoology.** Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. II; 1 unit. Prerequisite: Zoology 101. INGLE.

321. **Helminth Parasitology.** Worm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technic, readings, quiz, demonstrations, problems. I, II; 1 unit. Prerequisite: Zoology 132. THOMAS.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology: comparative anatomy, evolution and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous

systems. Lectures and laboratory. II; 1 unit. Offered in 1954-1955 and in alternate years. Prerequisite: Zoology 333. HALL.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. I, II; 1 unit. Prerequisite: Zoology 132. ADAMSTONE, KRUIDENIER.

334. **Vertebrate Histology.** Study and preparation of tissues of the vertebrate body. II; ½ unit. Prerequisite: Zoology 333, or consent of instructor. ADAMSTONE.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. II; ½ unit. Prerequisite: Zoology 101 or 104. FISHER, KENDEIGH.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. I; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Zoology 132. HOFFMEISTER.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. I; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Zoology 132. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. II; ½ unit. Offered in 1955-1956 and in alternate years. Prerequisite: Zoology 132. SMITH.

341. **Field Ecology.** Study of biotic communities, birds, and fish in the vicinity of Reelfoot Lake, Tennessee, covering six days. Students may enroll in subsequent years for additional credit by specializing in different fields of study. II; ¼ unit. Prerequisite: Registration in Zoology 240, or 335, or equivalent. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. I; ½ unit. Prerequisite: Zoology 101 or 104. SHOEMAKER.

343. **Limnology.** Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. II; ½ unit. Offered in 1954-1955 and in alternate years. Prerequisite: Zoology 101 or Botany 100. MATTESON.

345. **Animal Ecology.** Dynamics, development, and distribution of biotic communities. I; ½ to 1 unit. Prerequisite: One year of zoology. KENDEIGH.

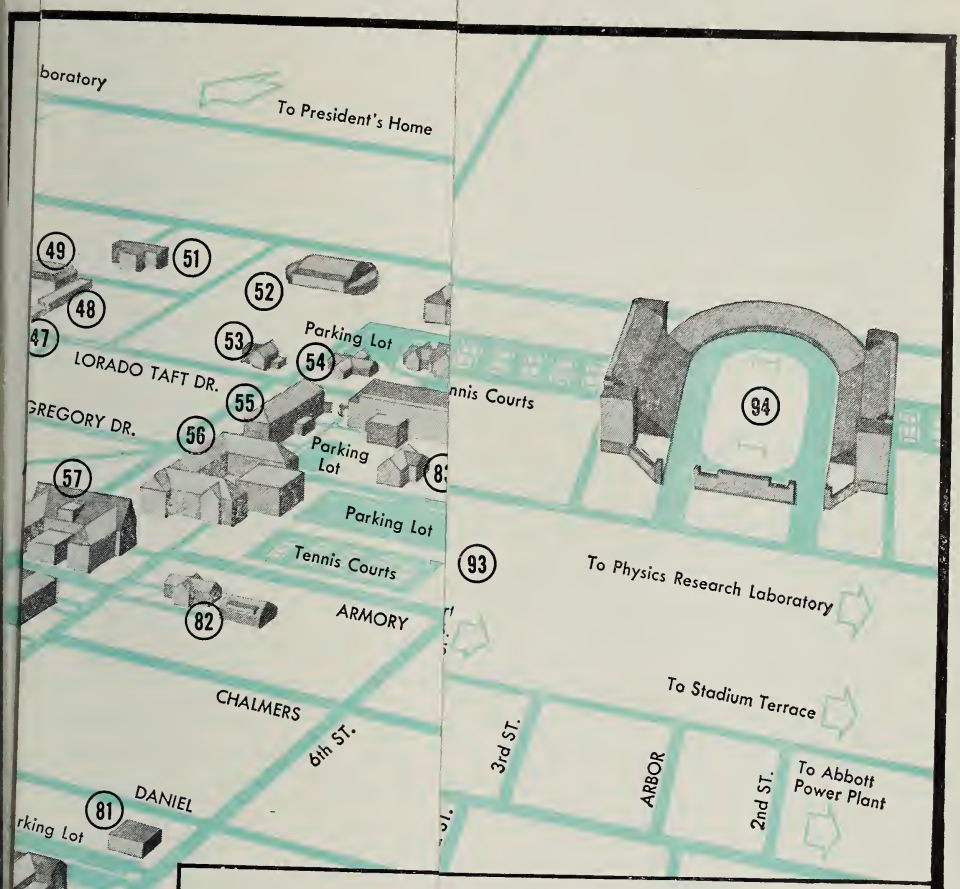
351. **Genetics.** Principles of heredity. Lectures, readings, and discussions. II; ½ unit. Prerequisite: Zoology 101 or 104, or one semester of any biological science. LUCE.

352. **Genetics.** Laboratory experiments illustrating the principles of heredity, problems, demonstrations. II; ½ unit. Prerequisite: Credit or registration in Zoology 351. KITZMILLER, LUCE.

361. **Comparative Physiology.** Same as Physiology 361. A comparison of the general physiology of different groups of animals. I; 1 unit. Prerequisite: Three semesters of animal biology; two semesters of chemistry. ANDERSON, PROSSER.

362. **Cellular Physiology.** Same as Physiology 362. A physico-chemical analysis of biological functions common to most living cells. II; 1 unit. Prerequisite: Two semesters each of biology and general physics; three semesters of chemistry. ANDERSON.

363. **Endocrinology.** Same as Physiology 363. The glands of internal secretion with special reference to the vertebrates. I annually; II in 1955-1956 and alternate years; 1 unit. Prerequisite: One semester of elementary zoology or physiology; Zoology 334 or organic chemistry. HALL.



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13 Theory Annex, School of Music
30 Transportation Building
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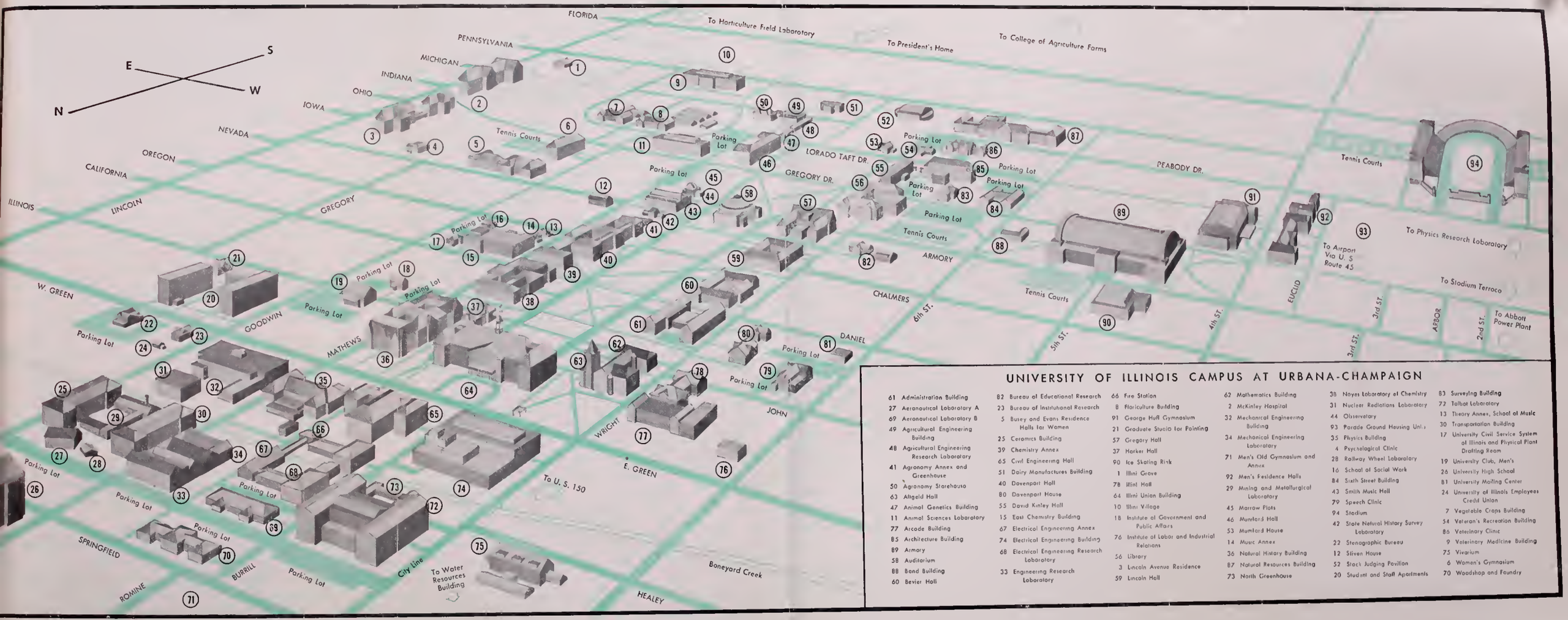
19 University Club, Men's
26 University High School
81 University Mailing Center
24 University of Illinois Employees Credit Union
7 Vegetable Crops Building
54 Veteran's Recreation Building
86 Veterinary Clinic
9 Veterinary Medicine Building
75 Vivarium
6 Women's Gymnasium
70 Woodshop and Foundry



UNIVERSITY OF ILLINOIS CAMPUS AT URBANA-CHAMPAIGN

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67 Electrical Engineering Annex
74 Electrical Engineering Building
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37 Harker Hall
90 Ice Skating Rink
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18 Institute of Government and Public Affairs
76 Institute of Labor and Industrial Relations
56 Library
3 Lincoln Avenue Residence
59 Lincoln Hall
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2 McKinley Hospital
32 Mechanical Engineering Building
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29 Mining and Metallurgical Laboratory
45 Morrow Plots
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35 Physics Building
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83 Surveying Building
72 Talbot Laboratory
13 Theory Annex, School of Music
30 Transportation Building
17 University Civil Service System of Illinois and Physical Plant Drafting Room
19 University Club, Men's
26 University High School
81 University Mailing Center
24 University of Illinois Employees Credit Union
7 Vegetable Crops Building
54 Veteran's Recreation Building
86 Veterinary Clinic
9 Veterinary Medicine Building
75 Vivarium
6 Women's Gymnasium
70 Woodshop and Foundry

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GRADUATE COLLEGE

UNIVERSITY OF ILLINOIS BULLETIN

1956
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1956–1957

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Milan Vaclav Novak, Ph.D., M.D., D.Sc., Professor of Bacteriology, Head of the Department of Bacteriology, Bacteriologist-in-Chief in the Research and Educational Hospitals, and Associate Dean of the Graduate College for the Chicago Professional Colleges

Thomas Albert Read, Ph.D., Professor of Metallurgical Engineering and Head of the Department of Mining and Metallurgical Engineering

Henry Sheldon Stillwell, M.S., Professor of Aeronautical Engineering and Head of the Department of Aeronautical Engineering

Abraham Haskel Taub, Ph.D., Research Professor of Applied Mathematics, Digital Computer Laboratory, Graduate College

William Victor Whitehorn, A.B., M.D., Professor of Physiology, College of Medicine

Calendar

1956—FIRST SEMESTER

Sept. 12, Wed.—Sept. 15, Sat.	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by September 1.)
September 15, Saturday	Latest date for registration of former students without payment of late registration fee.
September 17, Monday	Instruction begins.
September 28, Friday	Applications to take French examination on October 12 will not be accepted in Graduate College Office after this date.
October 5, Friday	Applications to take German examination on October 19 will not be accepted in Graduate College Office after this date.
October 12, Friday evening	French examination.
October 19, Friday evening	German examination.
October 29, Monday	Latest date for adding a course to program.
November 3, Saturday	Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to the "third" year.
November 5, Monday	Latest date for candidates for professional engineering degrees to file statements of professional study and experience.
November 16, Friday	Applications to take French or German examination on November 30 will not be accepted in Graduate College Office after this date.
November 21, Wed., 1 p.m.	Thanksgiving vacation begins.
November 26, Monday, 1 p.m.	Thanksgiving vacation ends.
November 30, Friday evening	French examination and German examination.
December 3, Monday	Illinois Day (State admitted to the Union, 1818).
December 10, Monday	Latest date for dropping a course without grade of E.
December 21, Friday, 1 p.m.	Christmas vacation begins.
December 31, Monday	Latest date for candidates for professional engineering degrees to submit outlines of theses.

1957

January 3, Thursday, 1 p.m.	Christmas vacation ends.
January 11, Friday	Latest date for candidates for Ph.D. degree in February to submit theses to Graduate College Office for approval of format.
January 17, Thursday	Study day. Classes dismissed.
Jan. 18, Fri.—Jan. 26, Sat.	Semester examinations.
January 18, Friday	No names will be added to the February graduation list after this date.
January 18, Friday	Latest date for candidates for the master's degree in February to deposit theses.

January 26, Saturday..... Latest date for finals for Ph.D. degree in February.

January 30, Wednesday..... Latest date for candidates for Ph.D. degree in February to deposit theses and abstracts.

1957—SECOND SEMESTER

Feb. 4, Mon.—Feb. 6, Wed..... Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by January 16.)

February 6, Wednesday..... Latest date for registration of former students without payment of late registration fee.

February 7, Thursday..... Instruction begins.

February 15, Friday..... Latest date for applications for fellowships for 1957-1958.

February 15, Friday..... Applications to take French examination on March 1 will not be accepted in Graduate College Office after this date.

February 22, Friday..... Applications to take German examination on March 8 will not be accepted in Graduate College Office after this date.

March 1, Friday evening..... French examination.

March 2, Saturday..... University Day (University opened, 1868).

March 8, Friday evening..... German examination.

March 16, Saturday..... Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to "third" year.

March 18, Monday..... Latest date for adding a course to program.

April 12, Friday..... Applications to take French examination on April 26 will not be accepted in Graduate College Office after this date.

April 16, Tuesday, 1 p.m..... Easter vacation begins.

April 19, Friday..... Applications to take German examination on May 3 will not be accepted in Graduate College Office after this date.

April 22, Monday, 1 p.m..... Easter vacation ends.

April 22, Monday..... Latest date for dropping a course without grade of E.

April 26, Friday evening..... French examination.

May 1, Wednesday..... Latest date for candidates for professional engineering degrees to deposit theses.

May 3, Friday..... Honors Day. Classes dismissed at noon.

May 3, Friday evening..... German examination.

May 17, Friday..... Latest date for candidates for Ph.D. degree in June to submit theses to Graduate College Office for approval of format.

May 24, Friday..... No names will be added to the June graduation list after this date.

May 24, Friday..... Latest date for candidates for the master's degee in June to deposit theses.

May 29, Wed.—June 7, Fri..... Semester examinations.

May 30, Thursday..... Memorial Day. No examinations.

June 1, Saturday..... Latest date for finals for Ph.D. degree in June.

June 5, Wednesday..... Latest date for candidates for Ph.D. degree in June to deposit theses and abstracts.

June 15, Saturday..... Commencement exercises.

1957—SUMMER SESSION

June 17, Monday	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 15.)
June 18, Tuesday	Instruction begins.
July 2, Tuesday	Applications to take French examination on July 12 will not be accepted in Graduate College Office after this date.
July 4, Thursday	Independence Day. No classes.
July 5, Friday	Applications to take German examination on July 19 will not be accepted in Graduate College Office after this date.
July 12, Friday evening	French examination.
July 19, Friday evening	German examination.
July 22, Monday	Latest date for dropping a course without grade of E.
Aug. 9, Fri—Aug. 10, Sat	Summer session examinations.
August 9, Friday	No names will be added to August graduation list after this date.
August 9, Friday	Latest date for candidates for the master's degree in August to deposit theses.
September 13, Friday	Latest date for candidates for Ph.D. degree in October to submit theses to Graduate College Office for approval of format.
September 27, Friday	Latest date to file application for the master's degree in October.
September 27, Friday	Latest date for candidates for the master's degree in October to deposit theses.
September 27, Friday	Latest date for finals for Ph.D. degree in October.
October 4, Friday	Latest date for candidates for Ph.D. degree in October to deposit theses and abstracts.

1957—FIRST SEMESTER

Sept. 11, Wed.—Sept. 14, Sat.	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by September 3.)
September 14, Saturday	Latest date for registration of former students without payment of late registration fee.
September 16, Monday	Instruction begins.
September 27, Friday	Applications to take French examination on October 11 will not be accepted in Graduate College Office after this date.
October 4, Friday	Applications to take German examination on October 18 will not be accepted in Graduate College Office after this date.
October 11, Friday evening	French examination.
October 18, Friday evening	German examination.
October 28, Monday	Latest date for adding a course to program.
November 2, Saturday	Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to the "third" year.
November 4, Monday	Latest date for candidates for professional engineering degrees to file statements of professional study and experience.

November 22, Friday	Applications to take French or German examination on December 6 will not be accepted in Graduate College Office after this date.
November 27, Wednesday, 1 p.m.	Thanksgiving vacation begins.
December 2, Monday, 1 p.m.	Thanksgiving vacation ends.
December 3, Tuesday	Illinois Day (State admitted to the Union, 1818).
December 6, Friday evening	French examination and German examination.
December 9, Monday	Latest date for dropping a course without grade of E.
December 20, Friday, 1 p.m.	Christmas vacation begins.
December 30, Monday	Latest date for candidates for professional engineering degrees to submit outlines of theses.

1958

January 2, Thursday, 1 p.m.	Christmas vacation ends.
January 10, Friday	Latest date for candidates for Ph.D. degree in February to submit theses to Graduate College Office for approval of format.
January 16, Thursday	Study day. Classes dismissed.
Jan. 17, Fri.—Jan. 25, Sat.	Semester examinations.
January 17, Friday	No names will be added to the February graduation list after this date.
January 17, Friday	Latest date for candidates for the master's degree in February to deposit theses.
January 25, Saturday	Latest date for finals for Ph.D. degree in February.
January 29, Wednesday	Latest date for candidates for Ph.D. degree in February to deposit theses and abstracts.

1958—SECOND SEMESTER

Feb. 3, Mon.—Feb. 5, Wed.	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by January 16.)
February 5, Wednesday	Latest date for registration of former students without payment of late registration fee.
February 6, Thursday	Instruction begins.
February 14, Friday	Applications to take French examination on February 28 will not be accepted in Graduate College Office after this date.
February 15, Saturday	Latest date for applications for fellowships for 1958-1959.
February 21, Friday	Applications to take German examination on March 7 will not be accepted in Graduate College Office after this date.
February 28, Friday evening	French examination.
March 2, Sunday	University Day (University opened, 1868).
March 7, Friday evening	German examination.
March 15, Saturday	Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to "third" year.
March 17, Monday	Latest date for adding a course to program.
April 3, Thursday, 1 p.m.	Easter vacation begins.

April 8, Tuesday, 1 p.m. ..... Easter vacation ends.
April 11, Friday ..... Applications to take French examination on April 25 will not be accepted in Graduate College Office after this date.
April 18, Friday ..... Applications to take German examination on May 2 will not be accepted in Graduate College Office after this date.
April 21, Monday ..... Latest date for dropping a course without grade of E.
April 25, Friday evening ..... French examination.
May 1, Thursday ..... Latest date for candidates for professional engineering degrees to deposit theses.
May 2, Friday ..... Honors Day. Classes dismissed at noon.
May 2, Friday evening ..... German examination.
May 16, Friday ..... Latest date for candidates for Ph.D. degree in June to submit theses to Graduate College Office for approval of format.
May 23, Friday ..... No names will be added to the June graduation list after this date.
May 23, Friday ..... Latest date for candidates for the master's degree in June to deposit theses.
May 27, Tuesday ..... Study day. Classes dismissed.
May 28, Wed.—June 6, Fri. ..... Semester examinations.
May 30, Friday ..... Memorial Day. No examinations.
May 31, Saturday ..... Latest date for finals for Ph.D. degree in June.
June 4, Wednesday ..... Latest date for candidates for Ph.D. degree in June to deposit theses and abstracts.
June 14, Saturday ..... Commencement exercises.

NOTES

Candidates for master's degrees must submit thesis titles to the Graduate College six weeks prior to graduation date.

The two language examinations required for the Ph.D. should be passed as early as possible and must be passed in the term preceding the preliminary examination or at least two months prior to that examination.

The general thesis topic is made known to the doctoral committee at the time of the preliminary examination. The final thesis title should be submitted to the Graduate College about three months prior to the conferring of the degree.

The thesis must be submitted to the Graduate College for approval of the format at least two weeks prior to the date of the final examination. See pamphlet "Instructions for Preparation of Theses," which can be obtained in Room 109 Administration Building (East).

Executive Officers of Fields of Instruction

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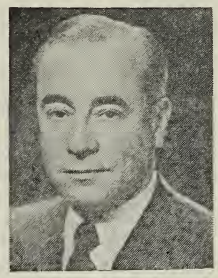
Zoology	Frank Bolton Adamstone

* Give work for master's degrees only.

GEORGE A. MILLER VISITING PROFESSORS AND LECTURERS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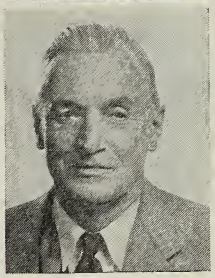
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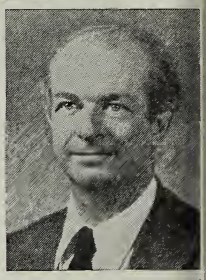
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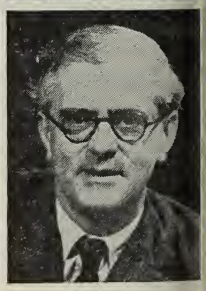
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7. Alf N. C. Ross—Law
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8. Alfred L. Rowse—History
   All Souls College, Oxford, England

The Graduate College

The University of Illinois offers graduate instruction on the Urbana campus and on the campus of the professional colleges in Chicago. This bulletin describes only the programs of study and the courses offered at Urbana. Questions concerning programs in the medical and dental sciences and in pharmacy should be directed to Dr. Milan Novak, Associate Dean of the Graduate College, Chicago Professional Colleges, 808 South Wood Street, Chicago 12, Illinois.

Character of Graduate Work. Formal instruction, though ordinarily necessary to supplement undergraduate preparation, is by no means the most important part of a graduate program. The main purpose of graduate work is to enable a student to broaden his knowledge of a given field and to increase his competence. Graduate work, especially in the second and third year of a doctoral program, aims at the development of independent scholarship, originality, and competence in research. Achievement of these aims is usually sought through instruction in small classes or seminars, according to methods, standards, and ideals which vary widely from one field to another.

Admission

Application blanks for admission can be obtained from the Dean of Admissions or from the Graduate College. They should be prepared in duplicate and returned to the Dean of Admissions. Official transcripts from all other colleges attended must be sent directly to the Office of Admissions by the colleges concerned. In order to avoid delay during the registration period, applications for admission should be submitted at least three weeks prior to the day instruction begins. An application will be accepted at a later date, but there may be delay in processing it.

Subject to the specific regulations described below, admission is granted to applicants who have a bachelor's degree corresponding to that granted by this University, providing the undergraduate preparation is adequate for advanced study in the major and minor fields.

Candidates for the Master's Degree. Admission with full standing is granted to applicants whose grade-point average for the last fifty per cent of the hours completed for the bachelor's degree (approximately

sixty semester hours) is at least 3.5 (A = 5.0). Required physical education and military training are not included in this computation. Certain departments require of entering graduate students a minimum grade-point average higher than 3.5. Information concerning the average required for admission to each field of study is given in the departmental sections. As of September, 1956, applicants whose grade-point average is below 3.5 are admitted with limited status for study in the areas of agricultural economics, anthropology, architecture and architectural engineering, dairy science, history, home economics, landscape architecture, mathematics, mining and metallurgical engineering, social work, sociology, speech, statistics, and veterinary pathology and hygiene. Students admitted on limited status may petition for full standing after completing at least three units of satisfactory work.

Candidates for the Doctor's Degree. Upon the recommendation of the head of the department of the major field of study and with the approval of the Dean of the Graduate College, admission with advanced standing is granted to applicants who have completed a master's degree or the equivalent elsewhere and who desire to become candidates for the doctor's degree at the University of Illinois. If the applicant is admitted, his year of advanced study completed elsewhere will be accepted as one year of residence, but the amount of credit to be accumulated at the University of Illinois before the candidate can be admitted to the preliminary examination can be determined only by the advisers in the major and minor fields after the student has registered and completed some work here.

Graduate Study by College Seniors. A college senior who has been in residence for at least two semesters and who is within five semester hours of his bachelor's degree may be admitted to the Graduate College if his grade-point average for the last fifty per cent of the hours completed is approximately 4.0. Seniors who meet these requirements and who wish to apply should submit an application for admission to the Dean of Admissions together with a letter from the dean of the undergraduate college specifying the hours needed to secure the bachelor's degree. If admitted to the Graduate College, the student carries as miscellaneous course work the hours needed to complete the requirements for the first degree; in addition, he registers for courses to be credited toward an advanced degree.

A senior who is within ten hours of the bachelor's degree may register in graduate courses for graduate credit if his grade-point average is that specified above and if he secures the approval of the head of the major department and the instructors concerned. In all such cases, the program card must be signed by the Dean of the

Graduate College before registration is completed. Graduate credit so earned does not count toward an advanced degree unless the student qualifies for admission with full standing at the close of the session and enrolls as a graduate student during the following regular semester.

Advisers. Every graduate student must have an adviser. The adviser's primary duty is to assist the student in planning and carrying through a program of graduate work which fits the needs and desires of the student, and at the same time satisfies departmental and Graduate College requirements. A new graduate student should go to his major department to discuss the selection of an adviser.

Students from Abroad. A student from abroad who wishes to be admitted to graduate study at the University of Illinois should write to the Dean of Admissions, 100a Administration Building, Urbana, Illinois, enclosing copies of his academic records certified by the educational institutions previously attended. No application form is submitted until the student arrives on the campus. Students whose native tongue is not English are required to take an examination in English before registration. If command of the language is not adequate, enrollment in courses for the study of English as a foreign language is required.

The Assistant Dean for Foreign Students, Mr. George H. Bargh, 152 Administration Building (West), assists students from abroad with problems involving passports, visas, and other matters.

Time Limit for Advanced Degrees. From the time of entrance upon graduate study at the University of Illinois, the work for a master's degree must be completed in not more than six calendar years, and that for a doctorate in not more than seven calendar years. If the completion of the requirements is delayed for reasons beyond the control of the student, he may request an extension of time by submitting a petition (see page 20).

Registration and Program of Studies

Registration. Dates for registration in the Graduate College are shown in the calendar (page 7). A former graduate student who registers late must pay a late registration fee of $5.00. The registration of a new student is accepted at any time, provided he is prepared to enter courses already under way for credit reduced in proportion to the length of time which has elapsed since instruction began. He is not charged the late registration fee.

A graduate student obtains a program card and other registration material, including an instruction sheet, from the Graduate College

office, 105 Administration Building (East), during scheduled registration days or at any time thereafter.

Changes in Program Cards. Because a graduate student is expected to plan his work carefully with his adviser, changes in his program during the semester should not be necessary. However, if, in the judgment of a student and his adviser, a change is required, the student should obtain a change-of-study form at the Graduate College office. This form must be signed by the adviser, the instructors involved, and the Dean of the Graduate College. After registration is completed, a fee of $1.00 is charged for each change; in cases of conflict or errors in registration the fee is waived at the discretion of the Graduate College office. Except in cases of illness certified by an attending physician, *a student is not permitted to drop a course during the last six weeks of a regular session.* The final date for dropping a course is shown in the calendar.

Unit Credit for Courses. Courses numbered from 300 to 399 are open to advanced undergraduate and graduate students, and those numbered 400 and above are open to graduate students only. Courses numbered below 300 do not carry graduate credit.

Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five. The credit which may be earned in individual courses is indicated in the course listing, and is in some instances variable.

Miscellaneous Courses. A graduate student carrying a normal graduate program may elect one miscellaneous subject (a course which does not give credit toward an advanced degree). If it is necessary for a graduate student to carry at the same time more than one miscellaneous subject, he may not register for a full graduate program. Courses intended to teach graduate students a reading knowledge of French or German are regarded as miscellaneous courses.

Auditing Privileges. A graduate student is permitted to attend classes as an auditor, provided a card bearing the approval of his adviser and of the instructor is filed at the Graduate College office. A student should not enter on his program card courses which he plans to attend as an auditor.

Graduate Programs for Employed Students. A student who is employed can not expect to complete his academic work as promptly as one who devotes full time to his academic program. The academic work carried by assistants and others on the University staff is limited

by statute, and no deviation is permitted without compelling reasons. Those employed outside the University are expected to reduce their program of work in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Nature of Appointment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1 unit
Two-thirds time	2¼ units	1 unit
Half time	3 units	1½ units
One-third time	3½ units	2 units
One-fourth time	4 units	2 units

Extramural Course Work. Graduate courses in a few areas of study are offered at various centers throughout the state. No student may register for more than one unit of extramural course work in any one semester, and no student who is employed full time may register for more than one unit each semester by enrolling for any combination of extramural and campus courses.

Extramural course work is not considered as work in residence. However, credit earned is accepted in partial fulfillment of the requirements for a master's degree providing the courses involved have been selected with the consent of the adviser and constitute part of a well-integrated program of study. Students accumulating credit for a master's degree through extramural course work must also meet the residence requirements for the degree desired (see general residence requirements for A.M. and M.S. on page 21 and for Ed.M. on page 110).

Credit earned in extramural courses can not be applied to advanced degrees beyond the master's. No credit toward an advanced degree is allowed for correspondence courses.

Grades. Grades are recorded by the following letters: A, B, C, D, E. Any student who receives two units of grade below B must complete two additional units of A or B grade to qualify for an advanced degree. Three units of a grade below B disqualify a student as a candidate. A grade of E in any course in the major field precludes the conferring of a degree in the academic year in which the failure is incurred.

Withdrawal. When a student drops all the course work in which he currently is enrolled, even if he is enrolled in only one course, he is considered to be withdrawing from the University. A student who wishes to withdraw from the University should obtain a withdrawal

slip from the Graduate College office. A student who leaves the University without completing the steps necessary for withdrawal receives failing grades in all course work. If a student withdraws from the University and wishes to register again, he must fill in an application for readmission. These forms are available at the offices of the Graduate College and the Dean of Admissions.

Graduate Study in the Summer. Credit earned during summer sessions may be applied to advanced degrees, subject to the residence requirement for the degree desired. The normal program for a summer term is two units; two and one-half units may be carried with the approval of the adviser. In no case is a student permitted to carry more than two and one-half units.

Petitions. The normal procedures and requirements of the Graduate College are indicated in this catalog, but these may be modified occasionally for justifiable reasons. A student may petition the Dean and the Executive Faculty of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms can be secured at the Graduate College office.

Residence. A student is in residence only when registered in the Graduate College and spending full time on the Urbana campus. Such a student earns one semester of residence if he is registered for two or more units. Students in residence who are carrying lighter programs of work must spend a proportionately longer time in satisfying this requirement; thus, for example, a full-time assistant registered for one unit each semester would discharge the residence requirement in four semesters of work. A student who is employed outside the Champaign-Urbana community is not considered to be in residence even though he is registered in a campus course.

Conferring of Degrees. Advanced degrees are conferred in February, June, August, and October, except the doctor's which is not awarded in August. Each student is responsible for entering on his registration cards at the proper time the fact that he is a candidate for a degree to be awarded at the end of the current term. If the candidate is not currently registered in the Graduate College, he must present his application to receive a degree at the Graduate College office no later than the final date specified in the calendar.

Each candidate for an advanced degree must obtain a clearance paper from the Graduate College after he has completed all his work. The student must obtain all the signatures called for on the form and return it to the Graduate College.

The Master's Degree

Requirements. A candidate for the master's degree must satisfy residence requirements and must complete at least eight units with satisfactory grades. It is expected that three of the eight units will be in courses numbered in the 400 series, and two of these must be in the major field. The teacher-training curricula and certain special programs are exempt from this regulation. Some departments require a thesis; others do not. A few require nine units of course work if the thesis requirement is waived. The candidate must satisfy the specific departmental requirements in addition to the general requirements of the Graduate College. Departmental requirements are stated in the catalog under the major areas of study.

Residence Requirements. A candidate for the master's degree (except the Ed.M.) is required to be in residence for the equivalent of at least two semesters. Attendance during four summer sessions in each of which the student is registered for not less than one unit of work, or in one semester with not less than two units and two summer sessions with not less than one unit each, is regarded as the equivalent of two semesters in residence. Registration for more than two units in a regular semester, or for more than one unit in a summer session, does not shorten the time which must be spent to discharge the residence requirement.

Work Done Elsewhere. A graduate student who has done graduate work in other approved institutions may petition to obtain credit, not to exceed four units, toward the master's degree by passing examinations in that work. Admission to such examinations requires the prior approval of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement of two semesters.

If it is recommended in advance by the adviser, the Graduate College may permit a student to register for work at a laboratory elsewhere offering facilities not available at Urbana, or in approved field work, with the understanding that such work will be accepted for graduate credit if completed satisfactorily. The adviser examines the student's transcript and examines the student directly when he returns to this campus and then makes a final recommendation to the Dean of the Graduate College concerning the credit to be given.

Majors and Minors. A candidate for a master's degree may do all his work in one field, or he may select a major and one minor, or a major and two minors, as indicated in specific cases in the latter part of this catalog. A major or minor denotes the field of knowledge of a

department, or such part thereof as constitutes a separate and independent division of that field. The adviser determines what courses in the major field are suited to the candidate's special objective, but the head of the minor department must approve the courses selected for the minor area of study. For a master's degree a major comprises work totaling a minimum of four units. Less than one unit of work does not satisfy the requirements for a minor.

Foreign Language. The ability to use one or more of the modern languages ordinarily studied in the undergraduate curriculum is desired for all candidates for the master's degree and is required in some lines of study. A student who plans to become a candidate for the Doctor of Philosophy degree should take at least one of the Graduate College language examinations during the first year of graduate study.

Master's Thesis. The subject of a thesis for the master's degree must be filed at the Graduate College office *by the student during the registration period prior to his graduation.* A student usually devotes two units of work to his thesis, and no more than three units of thesis credit may be included in an eight-unit program except by special permission. For specific instructions with reference to the preparation and form of the thesis, the student should obtain at the Graduate College office a copy of the leaflet "Instructions for Preparation of Theses." Two copies of the thesis with Certificates of Approval must be presented to the Graduate College office by the date specified in the calendar of the Graduate College. Candidates are expected to have at least four copies of the thesis. The original and first carbon must be deposited in the Graduate College; the other two are for the major department and the author. The Certificate of Approval for the master's thesis must be signed by the person under whose immediate supervision the thesis was prepared and also by the head of the major department. Blank certificate forms can be obtained at the Graduate College office.

The requirement of a thesis may be waived, on the recommendation of the department and with the approval of the Dean, *provided application to waive the thesis is made at the time for announcing thesis subjects.* A student excused from writing a thesis must replace it with courses of instruction. In this case, credit in research or thesis is not accepted in partial fulfillment of the requirements for the master's degree.

Thesis Work on Leave of Absence. A student who has completed six units of course work in residence and who wishes to complete the thesis in absentia should consult first with his adviser. If the request meets with the latter's approval, a petition is submitted. The petition

must include an outline of the proposed investigation and evidence that adequate facilities for pursuing it are available. If the work is to be done in an industrial laboratory, it is necessary to secure a letter from the company releasing to the University all patent and publication rights.

Teacher-Education Programs. Programs leading to the master's degree for teachers in various fields are offered to students who have satisfactorily completed the four-year undergraduate teacher-training program. Students who have not met all of the requirements of a four-year undergraduate curriculum but wish to take the fifth year of work for a master's degree may register in an approved program with the permission of the adviser and the Coordinator of Teacher Education. Two units of the required work in education may be completed in extramural graduate courses. Programs for teachers are offered in the following areas, the special requirements for each being given in this catalog at the page indicated:

Agriculture—page 46
Art—page 59
Biological Sciences and
General Science—page 64
Chemistry—page 77
Commercial Teaching—page 71
Education of the Deaf—page 109
Education of Mentally Handicapped Children—page 109
English—page 133
French—page 145
Geography—page 149
German—page 157
Health Education—page 230
Home Economics—page 166
Industrial Education—page 109
Latin—page 97
Mathematics—page 197
Mathematics and the Physical Sciences—page 198
Music—page 216
Physical Education—page 228
Physical Sciences—page 233
Physics—page 235
Social Studies—page 259
Spanish—page 274
Speech—page 278
Speech Correction—page 278

The Degree of Doctor of Philosophy

The degree of Doctor of Philosophy is offered in the fields indicated on page 12. The general requirements for the degree are described below. Special departmental requirements are described under the departmental listings. For information concerning the degree of Doctor of Education, see Education and Music.

Residence Requirements. For the degree of Doctor of Philosophy, the student must spend three "years" in resident study at an accredited educational institution, subsequent to the baccalaureate degree; such "years" are defined as follows:

First "Year." The time required to complete eight units of graduate work with satisfactory grades.

Second "Year." The time required to progress from the completion of the first year's work through the completion of the preliminary examination. This involves obtaining satisfactory grades in eight more units of graduate work, completion of the foreign language requirement, and passing the preliminary examination.

Third "Year." The time spent between passing the preliminary examination and the completion of all requirements for the doctor's degree, including eight units of research, writing a satisfactory thesis, and passing the final examination.

A student who spends the first two years in residence at the University of Illinois may petition to spend the last year in absentia. A student who has completed the first year of graduate work elsewhere must be in residence during the two remaining years. In exceptional cases, a student with two years of graduate study elsewhere who satisfies his major department that he has completed work equivalent to the standard departmental requirements is permitted to take his preliminary examination, provided he has fulfilled the language requirements. If such a student passes the preliminary examination, he may complete the requirements for the Doctor of Philosophy degree by devoting the third year to research in residence.

A student may satisfy the residence requirement in part by attending summer sessions at the University of Illinois. Attendance during four summer sessions is considered the equivalent of one year's residence. However, at some time during the second or third years of his doctoral program, the student must be in residence at the University through two successive semesters.

Major and Minor Subjects. A candidate for the degree of Doctor of Philosophy is required to pursue a major subject in the area of his research interest. He is also required to choose one or two minor subjects. The requirements for a minor in any field should be checked with the department concerned no later than the beginning of the second year, and earlier if possible. If only one minor is chosen, it is called a "sole minor," and must be taken in an area other than that of the major. It must consist of not less than four unit credits. If two minors are chosen, the first may be a subject closely related to the major. With the approval of the adviser, it may be a division of the major field of study; it must involve at least two units. In such a case, the second minor (not less than two units) must be taken in an area other than that of the major.

Language Requirements. The student is required to demonstrate his ability to read two of the following languages: French, German,

or Russian. He should take his language examinations as early as possible and must pass both not later than two months prior to the preliminary examination, or during the semester (or summer session) preceding that in which he is admitted to the preliminary examination. The dates of the language examinations and the latest dates when application for admission to these examinations may be made are shown in the calendar (page 7). Alternatively, a student will be certified in either language if he obtains a grade of B or better in French or German 401. Certification of proficiency in foreign languages is not accepted from other colleges or universities. The examinations must be taken at the University of Illinois.

Doctoral Committee. A permanent doctoral committee for each student is appointed by the Dean of the Graduate College upon recommendation of the executive officer of the department in which the student is doing his major work. The committee conducts the preliminary and the final examinations.

Preliminary Examination. A candidate for the doctor's degree must pass a preliminary examination intended to test his knowledge of his major and minor fields of study. He is not admitted to the examination before (1) he has passed the two required language examinations, (2) he has satisfactorily completed at least sixteen units of graduate work, and (3) his adviser and the head of the department of his minor field of study consider that he has adequate preparation in his major and minor fields. This examination, conducted by the candidate's doctoral committee, is partly or entirely oral. Consult the calendar of the Graduate College (page 7) for the latest dates for preliminary examinations.

Final Examination. When the thesis has been completed, if the major adviser so recommends, the candidate is given his final examination by his doctoral committee. A student in the third year of study who fails to meet the expectations of the professors in charge of his work, or in any way fails to maintain the standard of scholarship and power of research expected of him, may be refused admission to the final examination.

Consult the calendar of the Graduate College (page 7) for the latest date for the final examination. This examination is concerned primarily with the research work of the student as embodied in his thesis, but it may be much broader and extend over the whole field of study of the candidate. The intention of the final examination is to determine that the candidate has a satisfactory grasp of his major subject as a whole and a general acquaintance with the fields of knowledge represented by his course of study.

The final examination is oral and is conducted entirely in the presence of the doctoral committee.

Thesis. The Doctor of Philosophy is primarily a research degree; consequently, the candidate is required to demonstrate his capacity for independent research by the production of an original thesis on some topic connected with his major field of study. The subject of the thesis should be chosen by the end of the second year and must be reported to the doctoral committee and the Graduate College at the time of the preliminary examination. The student should register for credit in research in relation to the amount of time he plans to devote to his dissertation, four units being the equivalent of full-time work.

Not later than two weeks before the time set for his final examination, and not later than four weeks before the time when he hopes to receive the degree, the candidate must submit to the Graduate College, for approval of the format, two typewritten copies of his thesis in final form. Style and form must comply with the regulations given in the leaflet "Instructions for Preparation of Theses," copies of which can be obtained in the Graduate College office. It is expected that each candidate will have at least four copies of the thesis. The original and first carbon must be deposited in the Graduate College; the other two are for the major department and the author. After the thesis has been checked at the Graduate College office, the student must arrange for each member of the doctoral committee to read the thesis before the date of the final examination.

Formal publication of the thesis, either in its entirety or in a condensed form, is not required. However, students should consider the advantages, both to themselves and to their professional fields, of publication of the significant methods and findings of their research. If published, the article or book should have a note indicating that the material is, or is based upon, a dissertation submitted in partial fulfillment of the requirements for the Doctor of Philosophy (or other) degree at the University of Illinois.

In order to insure that theses are available for use by others, it is required that they be microfilmed. Each candidate who passes the final examination must pay a fee of $25.00 and deposit a typewritten abstract of his thesis, of approximately six hundred words, together with the original and first carbon of the complete thesis. This fee provides for (1) microfilming of the complete dissertation, with one copy deposited in the University of Illinois Library, (2) publication of an abstract of six hundred words or less in *Dissertation Abstracts.*

Professional Degrees in Engineering

The University of Illinois offers special programs of graduate study leading to the following professional degrees in engineering: Agricultural Engineer, Master of Architecture, Architectural Engineer, Ceramic Engineer, Chemical Engineer, Civil Engineer, Electrical Engineer, Engineer-Physicist, Mechanical Engineer, Metallurgical Engineer, and Engineer of Mines. (These degrees will be discontinued after July, 1958.)

Professional degrees in engineering may be conferred on two classes of candidates: (1) those who have received an academic degree in engineering or in architecture from the University of Illinois; (2) those who have received an academic degree in engineering, including chemical engineering, from other institutions of equal standing and who have been members of the teaching or research staff of the College of Engineering or Engineering Experiment Station or the Departments of Chemistry and Chemical Engineering or Architecture of the University of Illinois for at least three years prior to the conferring of the professional degree.

A candidate declares his candidacy by filing with the Dean of the College of Engineering, as chairman of the committee in charge, a detailed statement covering his professional engineering experience. This statement must be made on a standard form supplied by the Dean of the College of Engineering, and must be filed not later than the first Monday in November preceding the Commencement at which the candidate expects to receive the degree. No statement of experience is considered by the committee which does not show that the candidate has had a minimum of eight years of acceptable engineering experience after receiving the degree of Bachelor of Science, and that he has been in responsible charge of engineering work for at least five years. Responsible charge in engineering teaching may be considered as responsible charge of work. In determining the acceptability of the engineering experience of the candidate, the committee is guided by the character of his professional work and the degree of responsibility involved, and takes into consideration such evidences of professional ability and growth as may be shown by his investigation of engineering problems, contributions to technical literature, and his membership and activity in engineering societies.

If the professional experience of the candidate is accepted, he must submit for approval, before December 31, an outline of his proposed thesis. The completed thesis, in the form prescribed in the "Instructions for Preparation of Theses," must be submitted to the Dean of the College of Engineering for approval not later than May 1. Major technical

reports or plans and specifications for major engineering projects conceived and designed or directed by the candidate may be submitted for approval in lieu of a thesis. The candidate must attend Commencement in order to receive the degree.

A candidate for the professional engineering degree must pay the tuition fee of $25.00 on being notified that his professional experience is accepted as qualifying him to enter as a candidate for the degree. No one will be enrolled as a candidate for the degree at the following Commencement who does not pay his fee at this time. When a candidate for a professional engineering degree has once been accepted and paid his fee, he is eligible to receive the degree at any time within five years, without additional fee, on completion of the requirements. However, unless he completes the requirements within two years his name is dropped from the list of candidates and in order to receive the degree within the five-year period he must register again.

Applied Mathematics

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, are offered by various departments in the College of Engineering and the College of Liberal Arts and Sciences. Graduate students working in applied mathematics and interested in one or more of these particular fields register in one department of the University and work for the Master of Science or the Doctor of Philosophy degree in that department.

The Committee on Applied Mathematics advises graduate students interested in one of the branches of applied mathematics listed above. Students can call on the Committee for help in planning a basic course of study which will serve as preparation for subsequent specialization and research work in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical meteorology, or the mathematical problems related to digital computer use and design. The graduate degree toward which the student is working is supervised by the department of the student's specialization.

Detailed information concerning the programs of study and research in various branches of applied mathematics may be obtained by writing to the Chairman of the Committee on Applied Mathematics, Professor A. H. Taub, Digital Computer Laboratory.

Fellowships

Fellowships are awarded each year to promising graduate students for work in any field in which the Graduate College offers an advanced degree. In addition to the stipend, a fellowship award provides exemption from tuition and incidental fees, except the hospital and medical service fee, for the academic year in which the fellowship is effective and for the following eight-week summer session. The stipend is $1,200 for the academic year. In addition to these regular University fellowships, there are a number of industrial and endowed awards in several areas of study, including chemistry, engineering, agriculture, history, and political science.

An application for a fellowship can be obtained from the office of the Graduate College and must be returned to that office by February 15 to be considered for an award for the following academic year. Applicants in applied music or composition and in applied art are required to submit recordings, original scores, or examples of their art work in addition to the usual transcripts and letters of recommendation. These items should be mailed directly to the head of the major department.

A few special nonresident and postdoctoral fellowships are available each year. The nonresident fellowships are awarded to exceptional graduate students engaged in research projects which require direct observations or archival work elsewhere. In order to qualify for this award the student must have been in residence for at least one year and must submit a plan which has been approved by the major department. The postdoctoral fellowships are intended to provide opportunities for further training and development to outstanding students of great originality who wish to make use of the research facilities of the University after receiving the doctor's degree. A detailed program of research and study formulated by the applicant must be submitted with the application. Ordinarily, applicants for these special fellowships are interviewed by the Graduate Fellowship Committee.

Fellows are selected by the Graduate Fellowship Committee on the basis of scholarship and promise in teaching or research as revealed by transcripts, letters of reference, and recommendations by the major departments. Successful applicants will receive a notice of appointment on or about April 1 and are expected to accept or decline by April 15. (See statement of policy adopted by the Association of American Universities under Assistantships below). At the time an award is accepted at the University of Illinois, the Fellow agrees that without the consent of the Dean of the Graduate College he will

neither engage in any outside employment for remuneration nor hold concurrently any other fellowship carrying a stipend.

Assistantships

Nominations to teaching and research assistantships originate in the department, and inquiry concerning opportunities available should be directed to the head of the department concerned. The minimum salary for a full-time assistant is $3,000 for nine months or $3,660 for the calendar year. However, the usual appointment is on a half-time basis at $1,500 for the academic year. An assistant whose salary is less than $3,000 for nine months or $3,660 for twelve months is exempt from tuition and incidental fees except the hospital and medical service fee. Assistants must carry a reduced program of study as shown on page 19, but the additional length of time needed to complete the requirements for the degree desired is compensated by the gain in teaching or research experience.

Graduate assistantships for ten months with a stipend of $850 to $950 and exemption from tuition and fees are available to certain graduate students wishing residence hall experience in promoting successful group living, intelligent self-government, and optimum academic interests. Three units of graduate study may be pursued in counseling, guidance, or related fields, enabling the assistant to complete a master's degree in two semesters and a summer session. For further information, women may write to the Dean of Women, 100 Bevier Hall; male applicants should address the Dean of Students, 152 Administration Building (West).

The University of Illinois adheres to the following resolution adopted by the members of the Association of American Universities and a number of other graduate schools of North America:

"In every case in which a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or a prospective graduate student, the student, if he indicates his acceptance before April 15, will still have complete freedom through April 15 to reconsider his acceptance and to accept another fellowship, scholarship, or graduate assistantship. He has committed himself, however, not to resign an appointment after this date unless he is formally released from it."

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 2,900,000 volumes, all but about 200,000 volumes being located in Urbana. The remainder

are held by the Library of Medical Sciences in Chicago and the Undergraduate Division in Chicago.

In addition to the figures for cataloged volumes cited above, the University Library contains approximately 500,000 pamphlets, 173,000 maps, and 43,000 music scores and parts. More than 18,000 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archeology; sixteenth and seventeenth century English literature, especially the Milton-Shakespeare period; nineteenth century English literature; American humor and folklore; French, Italian, and Spanish literature; German literature of the sixteenth and seventeenth centuries; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

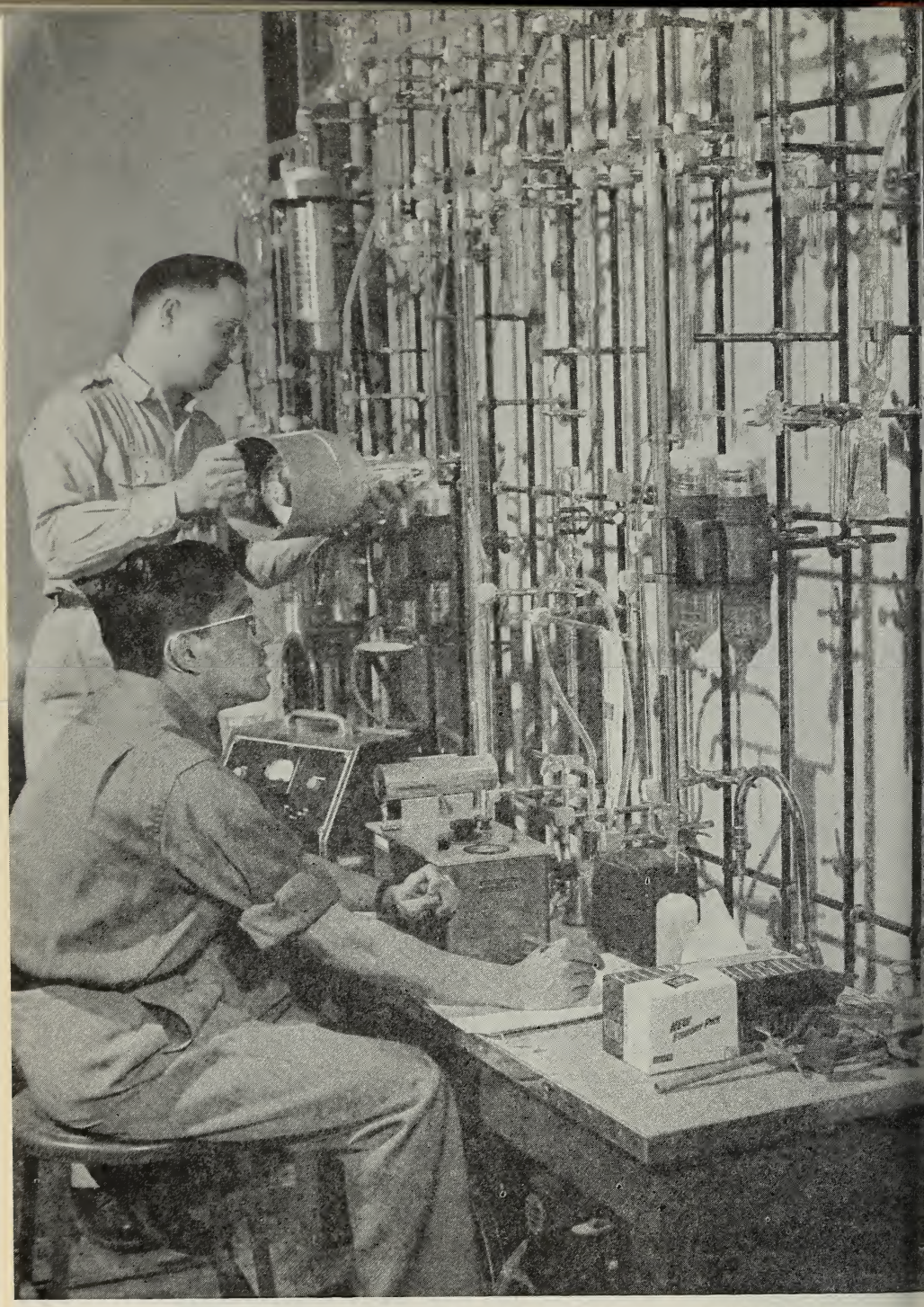
In the social sciences, the Library's holdings are significant for western United States history, Abraham Lincoln and the Civil War, Latin-American history of the Revolutionary period, Italian history, medieval and modern European history, German history for 1830-1900, Irish history, international law and relations, political science, law, economics, labor and industrial relations, and education.

For science and technology, collections of high rank are held in mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering, and agriculture.

The Library's bibliographical facilities comprise a union catalog of more than 3,000,000 cards, representing titles owned by about two dozen major American and foreign libraries; printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained. Following are the principal separately administered collections in the central library building: Classics; Commerce, Sociology, and Social Work; Education, Philosophy, and Psychology; English; Germanic and Romance Languages; History and Political Science; Library Science; and Physical Education.

Elsewhere on the campus are departmental libraries for the following fields: Agriculture, Architecture and Fine Arts, Chemistry, Engineering, Journalism, Landscape Architecture, Law, Mathematics, Music, Natural History (biological sciences, geology, and geography), Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine.



High vacuum system for handling volatile compounds labeled with radioactive carbon.

Further facilities available for graduate students are free access to the general bookstacks, housing about 2,000,000 volumes, and over 200 carrells in the bookstacks, assigned to individuals engaged in prolonged study and research. Interlibrary loan service from other institutions is provided for those engaged in research for dissertations.

Special Laboratory Facilities

Digital Computer Laboratory. The Digital Computer Laboratory offers instruction in courses and supervision of theses for individuals specializing in the design and use of the digital computing machinery which is now of such importance in research work in modern technology. The Laboratory possesses the Illiac, a high-speed general purpose computing machine which was built at the University of Illinois. Members of the staff who are engaged in computer research regularly offer four courses: Mathematics 383, 385, 457, and Mathematics and Electrical Engineering 384. Descriptions of these courses are given under the appropriate department headings.

Although no advanced degree is offered by the Digital Computer Laboratory, candidates for advanced degrees in electrical engineering, mathematics, or physics who are interested in this area of study may engage in thesis work under the supervision of one of the staff members in the Laboratory.

Active research is being carried out in the Boolean algebra of switching circuits, applied mathematics, computer circuits, and high-speed memories. A limited number of research assistantships are available for work carried out in the Laboratory. Requests for additional information concerning the work in the Laboratory and applications for assistantships should be directed to the Chairman of the Digital Computer Laboratory, 168 Engineering Research Laboratory.

Electron Microscope Laboratory. The Electron Microscope Laboratory is devoted to research work in behalf of all University departments. It is equipped with four different types of RCA electron microscopes, the original EMB, EMC (Console Type), EMT (table model with permanent magnet lenses), and a new EMU of latest design. These four microscopes with all auxiliary equipment are permanently located in an air-conditioned laboratory and their operation is under the direction of an expert electron micrographer. A seminar in electron microscopy is also offered for the purpose of training qualified graduate students from all departments in the technique.

Physical Environment Unit. The facilities of the Physical Environment Unit include rooms and an altitude chamber in which ranges of temperature, humidity, and pressure can be controlled, and basic med-

ical and physiological instruments. They are available for use by any department or division of the University needing controlled environmental conditions for special research or instructional work. Although primarily designed for studies with human subjects and animals, the facilities can also be used for limited engineering and physical science activities.

Research assistantships, while not available in the Physical Environment Unit, are available in some of the departments interested in the effects of environment on people and animals. Inquiries regarding such assistantships should be sent to the department offering the specific work in which the student is interested.

Radiocarbon Laboratory. The Radiocarbon Laboratory, an all-university facility maintained and directed by a permanent staff, conducts research on chemical, physical, and biological problems by use of the tracer technique with carbon-14. Modern radiochemical equipment for the synthesis, degradation, isolation, and assay of radioactive carbon compounds is available.

A carbon-14 course, Chemistry 496 and Animal Nutrition 496, introducing radioactive carbon as a unique and potent tool of investigation and emphasizing experimental techniques, is conducted by the staff one semester each year and is a prerequisite for student research in the Laboratory.

Fees and Expenses

Students registering for resident work pay fees each semester or summer session according to the following schedules:

SEMESTER FEES

	Regular Schedule (Over two units)	*Reduced Schedule (Two units or less)*
Tuition Fee		
Residents of Illinois	$ 65.00	$20.00 per unit
Nonresidents of Illinois	175.00	48.00 per unit
Laboratory, Library, and Supply Fee	11.00	5.50
Hospital and Medical Service Fee	7.00	7.00
Students who present evidence of participation in any other insurance system providing the same benefits as those covered by the University fee may petition the Dean of Students for refund of this fee. *Students registered for one unit or less are exempt from this fee.*		
Illini Union Service Charge	7.00	7.00
Students registered for one unit or less are exempt from this fee.		

SUMMER SESSION FEES

	Regular Schedule (Over one unit)	Reduced Schedule (One unit or less)
Tuition Fee		
Residents of Illinois	$ 32.50	$20.00 per unit
Nonresidents of Illinois	87.50	48.00 per unit
Laboratory, Library, and Supply Fee	5.50	2.75
Hospital and Medical Service Fee	3.50	3.50
Students registered for one-half unit or less are exempt from this fee.		
Illini Union Service Charge	3.50	3.50
Students registered for one-half unit or less are exempt from this fee.		

EXEMPTION FROM FEES

Holders of general scholarships are exempt from tuition fees only. University Fellows and all members of the academic and administrative staffs of the University may register for courses without payment of the tuition fee and the laboratory, library, and supply fee, provided their annual salary is less than the minimum salary for a full-time assistant ($3,000 for a nine-month appointment; $3,660 for a twelve-month appointment). Exempt under the same conditions are permanent employees on the nonacademic staff.

SPECIAL FEES

	Regular Schedule (Over one unit)	Reduced Schedule (One unit or less)
Late Registration Fee	$ 5.00	$ 5.00
Former students, whether on appointment or not, who register after the regular registration days in either semester are subject to this fee.		
Change of Program Fee		1.00
This fee is charged for every change slip issued after the completion of registration.		
"In Absentia"		
Students enrolled for thesis work for the master's or doctor's degree on leave of absence pay the regular tuition fee only, as listed above.		
Professional Degrees		25.00
This fee is payable by candidates for professional degrees in Engineering each year.		

Transcript Fee 0.50

Each student who has paid all his University fees is entitled to receive, without charge, one transcript of his record. For each additional transcript the fee is $0.50.

Service Charge for Deferred Fees

A service charge of ten per cent of the amount of fees deferred, but not to exceed $3.00 a semester, is assessed for the privilege of deferring fees. If deferred fees are paid in full within ten days after registration, the service charge is refunded except that a minimum service charge of $1.00 is retained by the University in all cases. The hospital and medical service fee, the Illini Union service charge, the service charge for deferring fees, and all charges from previous semesters must be paid on the day of registration.

EXPENSES

Although personal expenses may vary a great deal, the following estimates indicate the average cost for students: board, $15.00 to $18.00 a week; room rent, single rooms from $25.00 to $35.00 a month; double rooms from $20.00 to $25.00 a month for each person.

Housing

The University does not operate residence halls for graduate students. However, a limited number of one-room efficiency apartments for married students is available in the University-owned Student-Staff Apartment Building. Applications for these units may be obtained from the Housing Division, 108 Illini Hall, or the Graduate College. In addition, the Director of the Housing Division maintains a list of apartments and rooms available in private homes in the community.

Fields of Instruction

Courses open to graduate students are of two classes. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only.

Many courses for graduate students require some measure of previous preparation. By consultation with the instructor, a student may learn whether he has had the necessary prerequisites for a particular course.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

An applicant's undergraduate grade-point average must be at least 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students on limited status are not admitted.

Candidates who wish to make accountancy their major subject for an advanced degree must have had the equivalent of twenty hours of undergraduate work in accountancy and at least one course each in principles of economics and finance. Graduate students in other departments who choose accountancy as a minor must present similar courses, with fifteen instead of twenty hours in accountancy as a minimum. Students who can not meet these requirements are expected to remove any deficiencies during the first year of residence by taking prescribed courses without graduate credit.

Students who have received undergraduate degrees from colleges other than commerce and business administration and who have had no undergraduate work in accountancy may also remove deficiencies during the first year of residence. Courses without graduate credit are available which permit such students to remove deficiencies in one year. It is then possible for these students to earn a Master of Science degree in accountancy during the second year of residence. Requests for further information should be addressed to the head of the department.

A first-year student whose major is accountancy ordinarily is expected to take Accountancy 481 and 483.

A student who wishes to become a candidate for the Doctor of Philosophy degree with a major in accountancy must pass a preliminary examination showing a thorough knowledge of accounting theory; a thorough knowledge of certain areas of accountancy, the number and selection of which is to be determined by the adviser in consultation with the student; a general acquaintance with the subject matter and bibliography of other areas of accountancy; and proficiency in the field or fields outside the department offered as a minor or minors.

FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships are available in the Graduate College, as described in the beginning section of this catalog.

Part-time teaching assistantships are sometimes available for qualified students. Requests for application forms should be addressed to the head of the department, 321 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professors: C. A. Moyer (Head of Department), H. H. Baily, N. M. Bedford, R. I. Dickey, R. K. Mautz, H. L. Newcomer.

Associate Professors: Dorothy Litherland, K. W. Perry, W. E. Thomas, N. D. Wakefield.

Assistant Professors: H. E. Breen, G. D. Brighton, E. J. DeMaris, G. E. Lukas, D. H. Skadden, A. R. Wyatt.

COURSES FOR GRADUATES

401. **General Accounting Theory.** For non-accountancy majors. A general presentation of accounting divested of the technicalities of bookkeeping, cost accounting, auditing, income tax procedure, so that it may provide graduate students, who have had or will secure a minimum of technical preparation in the subject, with a useful understanding of its basic ideas and limitations. I; 1 unit. Prerequisite: Consent of instructor. Litherland.

424. **Specialized Systems.** Accounting procedures used by industrial and mercantile enterprises in handling their special problems; study of uniform accounting systems. I; 1 unit. Baily.

441. **Governmental Accounting.** Advanced study in accounting and other fiscal procedures of the federal government; state, county, and municipal governments; institutions. I; 1 unit. Lukas.

461. **Administrative Accounting.** Accounting as a tool for management: organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions, cooperation with public accountants and government agencies, and social responsibilities. I; 1 unit. Thomas.

466. **Cost Accounting.** A critical examination of cost accounting methods as to truth and expediency. I; 1 unit. Dickey.

471. **Accounting Reports.** Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. II; 1 unit. Wakefield.

472. **Auditing Standards and Techniques.** A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. II; 1 unit. Moyer.

473. **System Design and Installation.** Problems and procedures in connection with designing and installing accounting systems. II; 1 unit. Baily.

474. **Income Tax Development.** A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. II; 1 unit. Skadden.

481. **Concepts and Principles.** The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. I; 1 unit. Bedford, Moyer, Wyatt.

483. **Income Determination.** A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. II; 1 unit. Bedford, Mautz, Perry.

484. **The Accounting Theory of Business Income.** An examination of the development and essential characteristics of the accounting theory of business

income evaluated in the light of criticisms implicit in other concepts of income; the social significance of business income theory. I; 1 unit. MAUTZ.

487. **Surplus and Dividends.** The theories underlying the treatment of balance sheet items deserve close consideration in accounting, because the balance sheet reflects the effect of conflicting ideas about the bases for setting up restrictions on the freedom of directors to dispose of corporation assets as dividends. II; 1 unit. NEWCOMER.

489. **History of Accounting Theory.** An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. II; 1 unit. LITHERLAND.

491. **Thesis (M.S.).** Individual direction and guidance in writing theses, and seminar discussions of progress made. I, II; 1 unit. BEDFORD and others.

492. **Thesis (Ph.D.).** Individual direction and guidance in writing theses, and seminar discussions of progress made. I, II; 1 to 4 units. MAUTZ and others.

493. **Special Research Problems.** Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. I, II; ¼ to 2 units. MOYER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Advanced Accounting.** Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. I, II; ¾ unit. Prerequisite: Accountancy 106 and 108. BEDFORD, NEWCOMER, SKADDEN, WYATT.

324. **Accounting Systems.** A discussion of the systems used by contractors, department stores, finance companies, building and loan associations, banks, insurance companies, brokers, water companies. I, II; ½ unit. Prerequisite: Accountancy 106 and 108. BREEN.

341. **Governmental Accounting.** Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. I, II; ½ unit. Prerequisite: Accountancy 108. BRIGHTON, LUKAS.

362. **Business Budgets and Accounting Control.** Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. I; ¾ unit. Prerequisite: Accountancy 108. THOMAS.

366. **Advanced Cost Accounting.** Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. I, II; ½ unit. Prerequisite: Nine hours of accountancy, including Accountancy 106. DICKEY, THOMAS.

371. **Auditing.** Ethics of the accounting profession; auditing standards and procedures; programs of audit of various accounts; construction and indexing of working papers; report to clients. I, II; ¾ unit. Prerequisite: Accountancy 308. BREEN, DEMARIS, MAUTZ, WYATT.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. I, II; ¾ unit. Prerequisite: Accountancy 371. BREEN, MOYER, WAKEFIELD, WYATT.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. II; ¾ unit. Prerequisite: Accountancy 274 and 308. BRIGHTON, SKADDEN.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. I, II; 1 unit. Prerequisite: Credit or registration in Accountancy 371. BEDFORD, MAUTZ, WAKEFIELD.

378. **C.P.A. Problems.** Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory, auditing, ethics. I, II; 1 unit. Prerequisite: Accountancy 377. BREEN, NEWCOMER, PERRY.

AERONAUTICAL ENGINEERING

The Department of Aeronautical Engineering offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. The principal fields of study are aerodynamics, aircraft propulsion, and aircraft structures.

Students may apply for admission to graduate study in aeronautical engineering if they have a grade-point average of at least 3.5 for that portion of work which represents the last 50 per cent of the credits completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

The prerequisite for graduate study in aeronautical engineering is normally the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in aeronautical engineering. It is expected that graduate students with deficiencies in their aeronautical engineering background will demonstrate proficiency in the fundamentals of their chosen field by passing suitable courses or examinations to the satisfaction of their advisory committees.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Students plan their study programs in consultation with departmental advisory committees. Courses offered by departments other than aeronautical engineering may be included in the major area of study when these courses are of particular value to the work which students desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical engineering must have taken mathematics through the first course in differential equations and undergraduate aeronautical engineering courses, equivalent to those offered at the University of Illinois, which are prerequisites to study in the branch of the subject in which the minor work is to be pursued. Where special cases warrant deviation from these requirements, approval from the head of the department is required.

For information concerning applied mathematics, see page 28.

FELLOWSHIPS AND ASSISTANTSHIPS

The Graduate College offers fellowships for which students in aeronautical engineering are eligible, and in addition the Department of Aeronautical Engineering has a few industrial fellowships. Applications for these fellowships should be addressed to the Dean of the Graduate College.

A number of part-time teaching and research assistantships are available to well-qualified students. The stipend is $1,500 for a half-time assistant and $750

for a quarter-time assistant for the academic year, with exemption from tuition, laboratory, library, and supply fees. A half-time assistant may take up to three units of graduate work each semester. It is usually possible to assign an assistant to duties in the field of his special interest. Inquiries concerning these positions should be directed to the head of the department, 101 Transportation Building.

GRADUATE TEACHING FACULTY

Professors: H. S. Stillwell (Head of Department), J. M. Coan, M. Z. Krzywoblocki, R. W. McCloy.
Associate Professors: H. H. Hilton, A. I. Ormsbee.

COURSES FOR GRADUATES

411. **Advanced Aerodynamics of Compressible Fluids.** Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. I; 1 unit. Krzywoblocki.

412. **Theory of Turbulence.** Introduction to the classical and modern theories of turbulence: Reynold's, Prandtl's Kármán's, Kármán-Howarth's, Kolmogoroff's, Heisenberg's, Krzywoblocki's theories in compressible fluids; Kampe de Feriet's theory. II; 1 unit. Prerequisite: Consent of instructor. Krzywoblocki.

414. **Advanced Theory of the Boundary Layer, Wakes and Jets.** The modern concepts and solutions of the boundary layer theory (laminar and turbulent), including considerations of transition and stability as well as the applications to wake and jet theories. II; 1 unit. Prerequisite: Consent of instructor. Krzywoblocki.

415. **Wing Theory.** Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings in subsonic and supersonic flow. I; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Mathematics 346 or equivalent. Ormsbee.

417. **Newtonian Flow and Elements of Missile Ballistics.** Fundamental concepts of Newtonian fluids; surface temperature of bodies in free molecular flow; equations of motion of a rocket during and after burning; properties of rocket functions; terrestrial and extra-terrestrial dynamics of rockets. II; 1 unit. Prerequisite: Aeronautical Engineering 306 and 411, or consent of instructor. Krzywoblocki.

421. **Advanced Aircraft Shell Structures.** Shear lag and diffusion of load in stiffened panels; relaxation methods; restrained warping of stiffened boxes with and without cutouts; exact and energy solutions for buckling of non-uniform columns, continuous columns, and plates. II; 1 unit. Prerequisite: Aeronautical Engineering 222 or consent of instructor. Coan.

426. **Theory of Continuous Media.** Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or consent of instructor. Hilton.

427. **Thermal Stresses and Creep Buckling.** Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating

of plastic and linear and nonlinear viscoelastic columns and plates; life expectancy of structures under elevated temperatures; applications to high speed aircraft structures. I; 1 unit. Prerequisite: Aeronautical Engineering 426 or consent of instructor. HILTON.

431. **Aerothermodynamics.** The fundamental principles of classical and statistical thermodynamics as well as of fluid flow are treated. The laws of thermodynamics and aerodynamics are applied to problems, such as heat transfer by convection, heat transfer by conduction in laminar and turbulent flows, heat transfer in the boundary layer with fluid injection and suction. I; 1 unit. Prerequisite: Consent of instructor.

432. **Aerothermodynamics.** Theories of flame propagation, chemical kinetics of gaseous reactions and combustion of hydrocarbons, steady and non-steady flows with heat addition, and some special topics. II; 1 unit. Prerequisite: Consent of instructor.

451. **Aeroelasticity.** Advanced treatment of aerodynamic and dynamic structural phenomena associated with flexible aircraft: oscillating airfoils; bodies in unsteady flow; effect of deformations on airload distribution; three-dimensional flutter; dynamic response to gusts and landing impact. I; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Aeronautical Engineering 250, Mathematics 346, or equivalent. HILTON, ORMSBEE.

491. **Thesis.** Thesis in one of the fields of aeronautical engineering. I, II; 1 to 2 units. STAFF.

493. **Special Problems.** Theoretical and experimental investigations in the following fields: aerodynamics, aircraft power plants, aircraft structures, and aircraft components. I, II; 1 to 2 units. STAFF.

495. **Research.** Research in the various areas of the aeronautical sciences. I, II; ½ to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Foundations of Mechanics and Gravitational Theory.** Same as Astronomy 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to earth, precession of earth's axis, etc. I or II; 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE.

311. **Aerodynamics of Perfect Fluids.** Fundamental equations; plane irrotational flow; vortex flow; combination fields of flow; Kutta-Joukowski theorem; application of conformal transformation to fields of flow; particle paths; fields of flow relative to axes fixed in fluid; velocity potential; three-dimensional fields. I; ½ unit. Prerequisite: Aeronautical Engineering 211. KRZYWOBLOCKI.

316. **Stability and Control.** An introduction to dynamics of the airplane, airplane control, and airplane maneuverability. I; ½ unit. Prerequisite: Aeronautical Engineering 211; Mathematics 341 or 345. STILLWELL.

331. **Combustion, Fuels, and Lubricants.** A study of the phenomena of combustion and combustion calculations, characteristics of fuels and lubricants for reciprocating engines, air breathing jets, and rockets. I; ½ unit. Prerequisite: Mechanical Engineering 205. MCCLOY.

334. **Rocket Propulsion and Rocketry.** The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. II; ½ unit. Prerequisite: Mechanical Engineering 205 or equivalent, or consent of instructor.

391. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. I; ½ to 1 unit. Prerequisite: Consent of instructor. STAFF.

392. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. II; ½ to 1 unit. Prerequisite: Consent of instructor. STAFF.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the degrees of Master of Science and Doctor of Philosophy. The chief fields of specialization are farm management, land economics, marketing, prices and statistical analysis, and rural sociology. Graduate work is also offered in national agricultural policies and programs, finance, law as applied to agriculture, and in international comparative agriculture.

The graduate program in agricultural economics provides basic training for a wide range of employment in such areas as agricultural economic teaching, research, and extension; federal and state positions; foreign service; commercial marketing; professional farm management; agricultural credit, both public and private; and private business institutions which employ men trained for positions requiring a thorough knowledge of the economics of agriculture.

Students who desire to secure degrees in agricultural economics must have completed either (1) a course of study equivalent to that required for the degree of Bachelor of Science in Agriculture at the University of Illinois, and including twelve hours of agricultural economics and economics, or (2) twelve hours of undergraduate economics and agricultural economics, and at least eight hours in accountancy, business law, history, management, marketing, political science, and sociology. See also the requirements which must be met in order to take economics as a minor.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

A grade-point average of 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, is required for admission to graduate study. A student with a lower grade-point average may make up his deficiency by making satisfactory grades in twelve hours of additional undergraduate work in courses approved by the head of the department.

A candidate for the degree of Master of Science is required to register for at least two units in economics, including one unit of economic theory. For the degree of Doctor of Philosophy, he must register for at least five units in economics, including two units of economic theory.

If approved by the Department of Agricultural Economics and the Dean of the Graduate College, the required work in economics may be treated as a part of the major field. Otherwise, the work in economics is considered a first minor, in which case the program in that minor requires the approval of the Department of Economics (see requirements in economics for a minor in that field).

To take agricultural economics as a minor, the student must have had at least twenty hours of undergraduate work in economic and agricultural subjects.

ASSISTANTSHIPS

A number of part-time staff positions, both in research and teaching, are maintained. These provide practical training in research and teaching while a

student is pursuing his graduate training. In general, these assistantships are granted to students with master's degrees or the equivalent. Application blanks may be secured from the head of the department, 305 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: G. L. Jordan (Acting Head of Department), R. W. Bartlett, H. C. M. Case, H. W. Hannah (on leave 1956-1957), D. E. Lindstrom, R. C. Ross, C. L. Stewart, J. E. Wills.

Associate Professors: E. E. Broadbent, W. D. Buddemeier, C. L. Folse, T. A. Hieronymus, N. G. P. Krausz, R. J. Mutti, E. R. Swanson, V. I. West.

Assistant Professors: R. A. Kelly, W. N. Thompson.

COURSES FOR GRADUATES

401. **International Comparative Agriculture.** Agricultural and major food problems of various countries; procedures, national and international, for improved standards. I; 1 unit. Stewart.

404. **Economics of Agricultural Production.** Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. II; 1 unit. Swanson.

405. **Economic Policies and Programs Affecting Agriculture.** Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. I; 1 unit. Prerequisite: One semester of graduate work or consent of department.

418. **Land Economics.** Land classification methods and principles; land tenure systems in modern societies; land deterioration and restoration as private and public problems. II; 1 unit. Stewart.

425. **Farm Management Principles.** Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. I; 1 unit. Wills.

426. **Farm Management Investigational Methods.** History and development of farm management in the United States; critical analysis of research methods; use of random sampling; application of selected economic principles. II; 1 unit.

436. **Problems in Marketing Agricultural Products.** Factors influencing growth of markets; methods of cheapening and improving marketing processes; activities of government agencies; cooperative efforts. II; 1 unit.

441. **Agricultural Statistics.** Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. I; 1 unit. Prerequisite: An elementary course in statistics. West.

442. **Agricultural Prices.** Prices of agricultural products in the light of their history, value theory, monetary theory, and methods of statistical analysis. II; 1 unit. Prerequisite: Agricultural Economics 441; a course in economic theory. West.

491. **Seminar.** Thesis course. Each graduate student whose major is agricultural economics must register in the course, but only those writing theses acceptable for graduate degrees are given credit. I, II; ½ to 4 units.

493. **Agricultural Economics Research.** Individual research in the field of student's special interest. Credit is conditional upon completion of acceptable report of investigation. I, II; ½ to 2 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Financing Agriculture.** Capital and credit needs of farmers; agencies supplying credit needs; problems of borrowers and lenders. II; ½ unit. Prerequisite: Economics 102 and 103, or 108.

303. **Agricultural Law.** Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, and other problems involving agriculture. I, II; ½ unit. KRAUSZ.

305. **Agricultural Development and Policies.** Agricultural development in the United States presented as a basis for analyzing the effectiveness of past agricultural policies, delineating agricultural problems, and the need of developing sound agricultural policies in keeping with a sound national economy. I; ½ unit. CASE.

312. **Farm Appraisals.** Same as Agronomy 312. Valuation of farm real estate; soils, crops, management, buildings, drainage, land titles, prices, and taxes in relation to value. Local field trips; estimated expense, $7. II; 1 unit. Prerequisite: Agronomy 201 and Agricultural Economics 220, or equivalent. STEWART and others.

324. **Farm Operation.** Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5. II; ½ unit. Prerequisite: Agricultural Economics 220. WILLS.

325. **Advanced Farm Management.** Functions of management; planning for conservation and profit; fitting the livestock organization to the kind of crops produced and to market outlets; economic information for farm planning; measures of farm efficiency; labor and power problems. Field trips to study successful farms; estimated expense, $10. I; ½ to 1 unit. Prerequisite: Agricultural Economics 220. BUDDEMEIER.

331. **Grain Grading and Marketing.** Same as Agronomy 331 and Marketing 331. Factors affecting the quality of grain crops; standards employed in their classification and grading on the commercial market; laboratory practice in grain grading; a trip to a commercial grain grading laboratory; economic problems and market operations in grain marketing. I; ½ unit. Prerequisite: Agricultural Economics 230 and Agronomy 121, or consent of instructor. HIERONYMUS, WEIBEL.

332. **Livestock Marketing.** Same as Animal Science 332 and Marketing 332. Problems and practices in marketing livestock. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. BROADBENT.

333. **Marketing Horticultural Products.** Same as Horticulture 333 and Marketing 333. Products and their utilization; institutions, functions, and agencies; merchandising methods; economic problems involved in horticultural marketing. I; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or five hours of horticulture, or consent of instructor. KELLY.

334. **Marketing Dairy Products.** Same as Dairy Science 334 and Marketing 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5. II; ½ unit. Prerequisite: Agricultural Economics 230,

or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

341. **Agricultural Statistics.** Statistical methods with special application to agricultural problems, including price behavior. Students receiving credit in this course will not receive credit in Agriculture 216. I; ½ unit. JORDAN.

342. **Agricultural Prices.** A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. JORDAN.

Rural Sociology

COURSES FOR GRADUATES

407. **Topical Seminar in Rural Sociology.** Same as Sociology 407. Analysis of topics of special interest such as population, migration, rural cultural change, rural culture and personality development, rural regions, and comparative rural societies. I; 1 unit. Prerequisite: Six hours of sociology; a course in introductory statistics. STAFF.

477. **Rural Communities.** Same as Sociology 477. A study of rural community structure, functions, and processes, to give the student a concrete picture of how rural communities operate, and the forces which cause change in the group life of the people living in a rural community. Field trip; estimated expense, $5. II; 1 unit. LINDSTROM.

487. **Special Problems in Rural Sociology.** Same as Sociology 487. I, II; ½ to 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

317. **Structure and Function of Rural Society in America.** A functional analysis of the group, institutional, and class structure of contemporary American rural society, with emphasis on regional and subregional variations and the interdependence of the rural and other segments of the total American society. I; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Three hours of sociology, eight hours of social science, or consent of instructor. FOLSE.

377. **Rural Community: Organization and Analysis.** The nature of the town-country community with special emphasis on its structure and organization, the institutional and agency programs and their leaders. Designed specifically for students preparing for vocational agriculture, extension, and other private and public agency work in rural areas. I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Three hours of sociology or eight hours of social science. FOLSE.

AGRICULTURAL EDUCATION

This is a program leading to the degree of Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching vocational agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of vocational agriculture, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Education 311 and 312

and two of the following courses: Education 301, 302, 303, 304. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department. A program of study suited to the student's objective is suggested by the adviser from courses listed under the departmental headings.

A grade-point average of 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, is required for admission. Students on limited status are not admitted to this program.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall, Professor H. M. Hamlin, 103 Gregory Hall, and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

The Department of Agricultural Engineering offers graduate work leading to the Master of Science degree in Agricultural Engineering, with options for specialization in farm power and machinery, soil and water control, farm structures, rural housing, and rural electrification.

Candidates for the master's degree must have had the equivalent of the undergraduate curriculum at the University of Illinois. This specifically includes basic training in theoretical and applied mechanics and approximately twelve hours of advanced undergraduate design courses in civil engineering or mechanical engineering.

Students applying for admission must have a grade-point average of at least 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

FELLOWSHIPS AND ASSISTANTSHIPS

A few industrial fellowships are available. Requests for application forms should be directed to the Graduate College. Inquiries concerning part-time research or teaching assistantships should be directed to the head of the department, 206 Agricultural Engineering Building.

GRADUATE TEACHING FACULTY

Professors: F. B. Lanham (Head of Department), R. C. Hay, K. H. Hinchcliff, G. E. Pickard, R. I. Shawl.
Assistant Professors: R. W. Kleis, J. A. Weber.
Associate: J. H. Ramser.

COURSES FOR GRADUATES

471. **Farm Structures in Agricultural Production.** Farm structures as related to production, farm operation, and systems of farming; building management,

functional requirements, cost, and appraisal. Discussions, problem study, and reports. I; ½ unit. Prerequisite: Bachelor's degree in agriculture. LANHAM.

491. **Thesis.** I, II; 1 to 2 units. STAFF.

493. **Problems in Agricultural Engineering.** Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. I, II; 1 unit. Prerequisite: Bachelor's degree in agricultural engineering or other engineering curriculum, with credit in courses essential to the optional line of study; consent of head of department. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

331. **Function, Application, Adjustment, and Management of Farm Machinery.** A study of field and farmstead machinery as related to the needs of agricultural production, systems of farming, function, construction, maintenance, and operation cost. S; ½ unit. Offered in 1957 and in alternate years. Prerequisite: Agricultural Engineering 112 or 131, or consent of instructor. SHAWL.

332. **Design of Agricultural Machinery.** Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of design to problems. II; ½ unit. Prerequisite: Mechanical Engineering 271. PICKARD.

341. **Farm Power.** Basic theory, analysis, and testing of internal combustion engines specifically for use in farm tractors and in other farm power applications. I; ½ unit. Prerequisite: Mechanical Engineering 209. PICKARD.

351. **Hydraulics of Soil Conservation.** Hydrology, hydraulics, design construction, and cost estimates of erosion control structures, water conservation dams, agricultural drainage systems, and soil conservation practices; relationships of slopes, soils, crops, and practices. Lectures, field trips, and problems. I; ½ unit. Prerequisite: Civil Engineering 115; Theoretical and Applied Mechanics 232 and 234. HAY.

355. **Advanced Soil and Water Conservation Practices.** A study of conservation practices and their evaluation in relation to farm operations; planning, constructing, and checking of terraces, waterways, diversion ditches, ponds, and drainage systems. S; ½ unit. Prerequisite: Agricultural Engineering 111 or 252, or consent of instructor. HAY.

361. **Development and Function of Family Housing.** Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. II; ½ unit. HINCHCLIFF.

371. **Advanced Farm Structures.** II; ½ unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223; Civil Engineering 261. LANHAM.

381. **Farm Electrical Equipment.** Advanced course. Exploration and evaluation of the factors involved in the selection, arrangement, installation, and operation of equipment for applying electricity to farming operations. II; ½ unit. Prerequisite: Agricultural Engineering 241 or graduate standing in agriculture; consent of instructor. KLEIS.

393. **Special Problems.** Each student chooses a special problem for design, laboratory, or field work with library research. Work may be taken in two of the following subjects: drainage and soil erosion control, farm buildings, farm housing, farm power, farm machinery, rural electrification. I, II; ½ unit. Prerequisite: Approval of head of department. STAFF.

AGRONOMY

The Department of Agronomy offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, crop production, ecology, experimental design, forage crops, morphological development, physiology, plant chemistry, weeds and their control; or (2) soils: biology, chemistry and biochemistry, fertility, genesis and classification, management, physical and colloidal chemistry, physical edaphology, physics.

Students who have a grade-point average of at least 3.75 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, may apply for admission to the Graduate College in agronomy. Students are not admitted on limited status.

Fifteen semester hours in agronomy and related subjects are prerequisite for a minor and five additional hours for a major, but students with an unusually broad and thorough training in science may be exempted from certain of these requirements.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, bacteriology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics. A pamphlet giving specific prerequisites and requirements may be obtained from the head of the Department of Agronomy.

A candidate for the Master of Science degree must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units fulfill the requirements for a first minor for the Doctor of Philosophy degree.

More detailed information may be obtained by writing to the Department of Agronomy.

ASSISTANTSHIPS

Teaching and research assistantships become available in the department from time to time. Information concerning these positions may be obtained from the head of the Department of Agronomy, 216 Davenport Hall.

GRADUATE TEACHING FACULTY

Professors: M. B. Russell (Head of Department), O. T. Bonnett, R. H. Bray, E. B. Earley, J. E. Gieseking, J. A. Jackobs, W. C. Jacob, R. W. Jugenheimer, L. T. Kurtz, A. L. Lang, S. W. Melsted, R. T. Odell, M. M. Rhoades, O. H. Sears, E. H. Tyner.

Associate Professors: A. W. Burger, E. R. Leng, R. S. Stauffer.

Assistant Professors: D. E. Alexander, A. H. Beavers, R. H. Hageman, J. B. Hanson, C. N. Hittle, A. Klute, F. W. Slife, F. J. Stevenson, R. O. Weibel.

Collaborators: D. W. Chamberlain, R. W. Howell, C. A. Van Doren.

COURSES FOR GRADUATES

401. Soils Seminar. I, II; ¼ unit. Staff.

402. Chemical Properties of Soils: Their Relation to Soil Development and Plant Growth. Chemical properties of soils and soil materials; their significance in soil development and in growth and nutrition of crop plants. Lectures, discussions, assigned reading, and bibliography. I; 1 unit. Prerequisite: Agronomy 121 and Chemistry 101, 105, and 122, or equivalent. Melsted.

403. **Genesis, Morphology, and Classification of Soils.** Historical review of work in soil genesis; genetic factors of soil formation; soil-forming processes and reactions; classification and nomenclature of soils; properties and distribution of the major soil groups of the world. Assigned reading. I; ¾ unit. Prerequisite: Agronomy 301 or consent of instructor.

405. **Colloidal Chemistry of Soils.** Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. II; 1 unit. Prerequisite: Chemistry 240 or equivalent. GIESEKING.

411. **Soil Physics.** The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned reading. I; 1 unit. Prerequisite: Chemistry 240 or equivalent. KLUTE.

412. **Soil Organic Matter.** Basic considerations in organic matter transformation; the carbon and nitrogen cycles; microbiology of organic matter synthesis; chemical nature of soil organic matter. Lectures, discussions, and assigned reading. II; 1 unit. Prerequisite: Bacteriology 104; Chemistry 132. STEVENSON.

421. **Crops and Plant Breeding Seminar.** I, II; ¼ unit. STAFF.

422. **Pasture, Range, and Soil Conservation Research.** Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. II; 1 unit. Prerequisite: Agronomy 121 and 321 or 322. JACKOBS.

423. **Theory and Analysis of Plant Breeding Problems.** Genetics of crop plants; problems in selection and hybridization. II; 1 unit. LENG.

424. **Mineral Nutrition of Plants.** A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. II; 1 unit. Prerequisite: Botany 130 or consent of instructor. HAGEMAN.

425. **Development of Crop Plants in Relation to Production and Breeding.** Theories of morphology and morphogenesis; principles of development and differentiation; morphogenesis of crop plants; plant development in relation to crop production and breeding. Special emphasis on cereals and grasses. Lectures, demonstrations, and assigned reading. II; 1 unit. Prerequisite: Agronomy 121; Botany 100. BONNETT.

491. **Thesis.** I, II; ½ to 4 units.
(a) **Soils.** BEAVERS, BRAY, EARLEY, GIESEKING, KLUTE, KURTZ, LANG, MELSTED, ODELL, RUSSELL, SEARS, STAUFFER, STEVENSON, TYNER, VAN DOREN.
(b) **Crops.** ALEXANDER, BONNETT, BURGER, CHAMBERLAIN, HAGEMAN, HANSON, HITTLE, HOWELL, JACKOBS, JACOB, JUGENHEIMER, LENG, RHOADES, SLIFE, WEIBEL.

492. **Research.** I, II; ½ to 4 units.
(a) **Soils.** BEAVERS, BRAY, EARLEY, GIESEKING, KLUTE, KURTZ, LANG, MELSTED, ODELL, RUSSELL, SEARS, STAUFFER, STEVENSON, TYNER, VAN DOREN.
(b) **Crops.** ALEXANDER, BONNETT, BURGER, CHAMBERLAIN, HAGEMAN, HANSON, HITTLE, HOWELL, JACKOBS, JACOB, JUGENHEIMER, LENG, RHOADES, SLIFE, WEIBEL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Soil Survey, with Emphasis on Illinois Soils.** Properties and methods used in distinguishing soils; characteristics and distribution of different soils in

Illinois and the cause of these soil differences; the influence of differences in Illinois soils upon their proper use and management. Laboratory work includes instruction in the use of soil maps, training in mapping soils, and field trips to examine representative Illinois soils. Field trips; estimated expense, $15. II; ½ unit. Prerequisite: Agronomy 201. ODELL.

302. **Role of Microorganisms in Soil Fertility.** Microorganisms of the soil in relation to fertility; nitrogen fixation, assimilation, and preservation. I; ½ unit. Prerequisite: Agronomy 201. SEARS.

305. **Laboratory in Soil Physics.** Introductory and advanced laboratory experiments illustrating principles and methods of physical studies of soils. The work is graded according to the previous training of the student. I; ½ unit. Prerequisite: Agronomy 201 or equivalent; consent of instructor. KLUTE, STAUFFER.

306. **Fertilizers and Their Soil Reactions.** Fertilizer sources and materials; chemical forms of elements in the soil, reactions of fertilizers in soils, determination of fertilizer needs, soil test methods, fertilizer application. I; ½ unit. Prerequisite: Agronomy 201. BRAY.

307. **Principles of Soil Conservation.** National and local implications of soil conservation and its relation to farming systems, land management, climate, soil character and farming operations. II; ½ unit. Prerequisite: Agronomy 121 and 201. STAUFFER.

308. **Plant Composition and Chemurgy.** Supply, chemical composition, and utilization of the principal sugar, starch, cellulose, oil, and protein crops of the world; the effect of nutritional, environmental, and genetic factors on chemical composition of these crop plants. II; ½ unit. Prerequisite: Chemistry 132 or equivalent. EARLEY.

311. **Physical Edaphology.** The underlying principles of the influence of physical properties of soils on plant growth; the application of these principles to practical problems of tillage, drainage, conservation, and plant nutrition. II; ½ unit. Prerequisite: Agronomy 201. RUSSELL.

312. **Farm Appraisals.** Same as Agricultural Economics 312. Valuation of farm real estate; soils, crops, management, buildings, drainage, land titles, prices, and taxes in relation to value. Local field trips; estimated expense, $7. II; 1 unit. Prerequisite: Agronomy 201 and Agricultural Economics 220, or equivalent. STEWART and others.

321. **Crop Ecology.** The environmental requirements of crop plants and their physiological bases; how well the environment provides for these requirements, particularly in the United States; the distribution and yield of specific crops as a function of environment. I; ½ unit. Prerequisite: Agronomy 121. HANSON.

322. **Forage Crops and Pastures.** Roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. Lectures and discussions. II; ½ unit. Prerequisite: Agronomy 121. JACKOBS.

323. **Improvement of Farm Crops by Breeding.** Heredity and variation in crop plants; effects of self-fertilization and cross-fertilization; principles and results of selection and hybridization in crop improvement. I; ½ unit. Prerequisite: Agronomy 110 or equivalent; Agronomy 121. BONNETT.

325. **Corn Breeding.** Principles and procedures involved in developing, testing, and production of inbred lines and hybrids; production and processing of hybrid seed corn; genetics of corn. II; ½ unit. Prerequisite: Agronomy 110. JUGENHEIMER.

326. **Weeds and Their Control.** Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of

the Midwest. Field trip; estimated expense, $5. I; ½ unit. Prerequisite: Agronomy 121. SLIFE.

327. **Forage Crop Breeding.** Principles and methods of plant breeding as related to forage crops: sources of hereditary variation, identification of desirable types, methods of evaluating breeding materials, and the utilization of desirable variations are discussed; cytological, genetical, and breeding investigations of the more important forage species and the development of improved varieties are considered. I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Agronomy 110 or equivalent; Agronomy 323 or consent of instructor. HITTLE.

331. **Grain Grading and Marketing.** Same as Agricultural Economics 331 and Marketing 331. Factors affecting the quality of grain crops; standards employed in their classification and grading on the commercial market; laboratory practice in grain grading; a trip to a commercial grain grading laboratory; economic problems and market operations in grain marketing. I; ½ unit. Prerequisite: Agricultural Economics 230 and Agronomy 121, or consent of instructor. HIERONYMUS, WEIBEL.

340. **Statistical Methods for Biological Research.** Same as Animal Science 340, Dairy Science 340, and Horticulture 340. A study of statistical methods as tools for research. When, where, and how to use the methods are stressed along with basic concepts of methodology. I; 1 unit. JACOB.

341. **Designing Experiments for Biological Research.** Same as Animal Science 341, Dairy Science 341, and Horticulture 341. Principles of experimental design are discussed and the available designs of simpler form are studied from the viewpoint of when and how to use them. Specialized applications of experimental designs are taken up. II; 1 unit. Prerequisite: Agronomy 340 or equivalent. JACOB.

377. **Diseases of Field Crops.** Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Plant Pathology 317 or consent of instructor. BEVER, GERDEMANN.

ANIMAL SCIENCE

(Including Animal Nutrition)

The Department of Animal Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Animal Science and in Animal Nutrition. For a major or a minor for the master's degree, the student may specialize in the general field of livestock or poultry production, or in the special fields of animal genetics and physiology, animal nutrition, or meats. For a major or a minor for the doctor's degree, he may specialize in animal genetics and physiology, animal nutrition, or in the general field of animal science.

The minimum grade-point average for admission to graduate study in the department is 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

A student who wishes to register for a minor in animal science for either the master's or the doctor's degree must offer at least fifteen college credits in the field, including the principles of feeding, the principles of genetics, and livestock production and management, and he must have had an introductory course in organic chemistry. For a major, a student must offer at least five additional college credits in animal science or in courses related to his major field of specialization. To qualify for graduate study in the field of meats, a student must offer

credit in Animal Science 104, 204, and 205, or their equivalents. Besides these general requirements, a student must have had the special training necessary for effective graduate study in the field of his chosen major.

Introductory courses in physiology and zoology, and in mathematics prerequisite to or including statistics, are desirable preparation for graduate work in any phase of animal science or animal nutrition. A reading knowledge of French and German, if acquired prior to registration in the Graduate College avoids the necessity of devoting time to these subjects while also carrying course work in the student's special field of interest.

Students who take a major or a minor for the doctor's degree in the general field of animal science must take Animal Nutrition 401 and a course in animal genetics if they have not previously taken these courses or their equivalents. All students taking a major or a minor in Animal Science are expected, while in residence, to attend and participate in Animal Science 400, Seminar, and must register in the course for a minimum of two semesters.

ASSISTANTSHIPS

Some research and teaching assistantships are available to students who can qualify for a major and who have a scholastic record of 4.0 or better. Applications should be addressed to the head of the department, 328 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: L. E. Card (Head of Department), R. M. Forbes, U. S. Garrigus, B. C. Johnson, J. Kastelic, A. V. Nalbandov, A. L. Neumann, H. M. Scott, S. W. Terrill.
Associate Professors: D. E. Becker, G. Wolf.
Assistant Professors: B. C. Breidenstein, H. H. Draper, A. H. Jensen, S. P. Mistry.

COURSES FOR GRADUATES

400. **Seminar.** A review of current literature in the science of animal production. I, II; ¼ unit. Staff.

401. **Principles of Beef Production.** A critical study of the objectives, design, and results of beef cattle experiments. II; 1 unit. Prerequisite: Consent of instructor. Neumann.

402. **Principles of Sheep and Wool Production.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. II; ½ unit. Prerequisite: Consent of instructor. Garrigus.

403. **Principles of Swine Production.** A critical study and interpretation of experiments in swine feeding, breeding, and management. Intended to aid in preparing students for positions in colleges, experiment stations, and related fields. II; ½ unit. Prerequisite: Consent of instructor. Terrill.

404. **Principles of Poultry Production.** A discussion of research methods and findings in the field of poultry science, with some consideration of current industry problems. I; ½ unit. Prerequisite: Consent of instructor. Scott.

405. **Advanced Animal Genetics.** Genetic theory, analysis of animal breeding problems, genetic results of selection and different systems of breeding. I; 1 unit.

406. **Physiology of Reproduction.** Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. II; 1 unit. Nalbandov.

407. **Laboratory Methods in Animal Genetics.** I, II; ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor.

408. **Laboratory Methods in Physiology of Reproduction.** I, II; ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor.

410. **Research Methods in Animal Science.** Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. I, II; ¼ to 1 unit. Prerequisite: Consent of instructor. BREIDENSTEIN, GARRIGUS, NEUMANN, SCOTT, TERRILL.

411. **Population Genetics and Animal Breeding.** Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. II; 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

491. **Research and Thesis.** Work may be taken in the following subjects: factors in livestock production, animal genetics, animal physiology, poultry, and meats. I, II; ½ to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Beef Production.** The principles of feeding and management of beef cattle; financial aspects of beef production; diseases, parasites, and breeding difficulties of beef cattle. Lectures, demonstrations, and discussions. I, II; ¾ unit. Prerequisite: Animal Science 102. NEUMANN.

302. **Sheep Production.** The sheep and wool industries; principles and practices of various phases of production. II; ¾ unit. Prerequisite: Animal Science 102. GARRIGUS.

303. **Pork Production.** The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. I, II; ¾ unit. Prerequisite: Animal Science 102. BECKER, JENSEN.

304. **Poultry Management.** Poultry Science and practice with special reference to the place of the poultry enterprise on Illinois farms. Veterinary students are required to take the laboratory. All others may register with or without the laboratory. II; ¾ unit. Prerequisite: Animal Science 102. SCOTT.

305. **Genetics and Animal Improvement.** Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement. II; ¾ unit. Prerequisite: Animal Science 110 or equivalent. ROBERTS, TOUCHBERRY.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. I; ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 101. VANDEMARK.

332. **Livestock Marketing.** Same as Agricultural Economics 332 and Marketing 332. Problems and practices in marketing livestock. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. BROADBENT.

340. **Statistical Methods for Biological Research.** Same as Agronomy 340, Dairy Science 340, and Horticulture 340. A study of statistical methods as tools for research. When, where, and how to use the methods are stressed along with basic concepts of methodology. I; 1 unit. JACOB.

341. **Designing Experiments for Biological Research.** Same as Agronomy 341, Dairy Science 341, and Horticulture 341. Principles of experimental design are discussed and the available designs of simpler form are studied from the viewpoint of when and how to use them. Specialized applications of experimental designs are taken up. II; 1 unit. Prerequisite: Animal Science 340 or equivalent. JACOB.

Animal Nutrition

The Division of Animal Nutrition offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. The areas of study within the division include the nutritive requirements of various species of animals and of man, with particular reference to farm animals, the nutritive evaluation of farm feeds and human foods by chemical analysis and appropriate animal assays, and the functions of food energy, proteins, carbohydrates, fats, and minerals and the micronutrients, minerals and vitamins in the animal organism.

The minimum grade-point average for admission to graduate study in animal nutrition is 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

To qualify for a major in this field, a student must have an adequate training in chemistry (including five hours of organic chemistry, five hours of analytical chemistry, and preferably five hours of agricultural biochemistry or food analysis, and five hours of physical chemistry) and in mathematics, including or prerequisite to, statistics. Introductory courses in physiology and bacteriology, and in French and German, are desirable prerequisites for a major in animal nutrition. For a first minor, three hours of organic chemistry and five hours of agricultural biochemistry or of quantiative chemical analysis are required. For a second minor, only the prerequisites for the selected courses in animal nutrition need be offered.

ASSISTANTSHIPS

Some research and teaching assistantships are available in animal nutrition to students who can qualify for a major in the field and who have made an acceptable scholastic record (4.0 average or better) in undergraduate or graduate work. Applications should be addressed to the head of the department or to the head of the division.

COURSES FOR GRADUATES

401. **Principles of Animal Nutrition.** Physical and chemical properties of nutrients; digestion and metabolism; functions and utilization of nutrients; principles involved in determining the nutritive requirements of animals. I; 1¼ units. Prerequisite: Chemistry 132, 133, or 234. FORBES.

402. **Advanced Course in Animal Nutrition.** A factorial study of the nutrient requirements of animals and man, and of the net nutritive values of feeds and food materials; comparative nutrition. II; 1¼ units. Prerequisite: Animal Nutrition 401 or equivalent. KASTELIC.

403. **Laboratory Methods in Animal Nutrition.** Techniques of animal nutrition investigations. I, II; 1 unit. Prerequisite: Chemistry 122 or equivalent. FORBES.

405. **Animal Nutrition Seminar.** I, II; ½ unit. Prerequisite: Animal Nutrition 402 or equivalent; consent of instructor. STAFF.

407. **Vitamins in Nutrition.** Nutritional requirements for individual vitamins; physiological function; metabolism and deficiency symptoms in different

species. I; 1 unit. Prerequisite: Animal Nutrition 401 or Chemistry 350. JOHNSON.

491. **Research and Thesis.** I, II; ½ to 4 units. DRAPER, FORBES, JOHNSON, KASTELIC, MISTRY.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. I; 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Animal Nutrition.** For students whose major is not animal nutrition, but who desire an introduction to the principles and practical applications of the science to animal feeding. II; ¾ unit. Prerequisite: Animal Science 102; Chemistry 132. DRAPER.

304. **Methods of Vitamin Assay.** A study of the principles underlying chemical, biological, and microbiological methods for the assay of vitamins, and the technical procedures that have been developed for this purpose. II; ½ to 1 unit. Prerequisite: Chemistry 350 or equivalent. MISTRY.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the degrees Master of Architecture and Master of Science in Architectural Engineering. Fields of specialization are architectural design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles), advanced structural theory and design, materials and methods of construction, and history of architecture.

The prerequisite for graduate work in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. Students whose preparation is considered inadequate may be required to take certain undergraduate courses without credit.

Students applying for admission must have a grade-point average of at least 3.5 for the last sixty semester hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are admitted on limited status.

ASSISTANTSHIPS

A limited number of part-time teaching (i.e., drafting room supervision, grading, or teaching) assistantships are available to graduate students of superior ability. The stipend for half-time assistants is $1,500 for the academic year of two semesters, plus exemption from the payment of tuition. The duties require twelve to twenty hours per week and the remainder of the time is devoted to graduate study. Three semesters are usually necessary to enable such assistants to complete the requirements for the master's degree. Inquiry regarding assistantships should be addressed to the chairman of the department, 104 Architecture Building.

GRADUATE TEACHING FACULTY

Professors: A. K. LAING (Chairman of Department), T. C. BANNISTER, H. L. HORNBEAK, W. S. KINNE, JR., R. P. LINK, E. LOVE, C. E. PALMER, A. M. RICHARDSON, C. K. WANG.

COURSES FOR GRADUATES

417. **The Development of Contemporary Architectural Thought.** An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, van der Rohe, Viollet-le-Duc, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, Serlio, and Vitruvius. I, II; ½ unit. Prerequisite: Consent of instructor. LAING.

431. **Architectural Procedures.** A study of architect-client relationships, budgetary factors, program development, idea conception, techniques of idea development and presentation, and the use of design check lists. I; ½ unit. Prerequisite: Consent of instructor. RICHARDSON.

435. **Advanced Architectural Design.** Advanced study of space relationships, building groups, and the integration of structural, mechanical, and aesthetic elements in architecture. I, II; 2 units. Prerequisite: The degree in architecture (general option) offered by the University of Illinois, or equivalent. RICHARDSON.

452. **Advanced Theory of Structures.** Slope-deflection and moment-distribution methods applied to gable frames and members with variable cross-section; the column-analogy method; fixed arches; secondary stresses; composite structures; complex structures. I, II; 1 unit. Prerequisite: Civil Engineering 461 or consent of instructor. WANG.

454. **Advanced Structural Design in Reinforced Concrete.** Critical review of the methods and specifications involved in the design for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way, and flat-slab floor construction; columns and footings; rigid frames and fixed arches; torsion; plastic theory of design; continuity in building design; introduction to prestressed concrete. I, II; 1 unit. Prerequisite: Architecture 358 or consent of instructor. WANG.

481. **Advanced Architectural Construction.** A study of traditional and contemporary building construction techniques; cost, maintenance, and depreciation factors in the building industry. May be taken concurrently with Architecture 491. I, II; ½ unit. Prerequisite: Consent of instructor. KINNE.

491. **Special Problems in Architectural Construction.** Individual direction in the investigation of selected topics in building construction. I, II; ½ to 2 units. Prerequisite: Credit or registration in Architecture 481. KINNE.

493. **Special Problems in Structural Theory and Design.** I, II; ½ to 2 units. Prerequisite: Credit or registration in Architecture 452. WANG.

494. **Special Problems in Architectural Design.** Individual or group investigation of building types, aesthetic problems, and other aspects of architecture. I, II; ½ to 2 units. Prerequisite: Architecture 435. RICHARDSON.

496. **Special Problems in History of Architecture.** Individual investigation of the work of particular architects, specific buildings, or the architecture of periods or regions; comparative studies; aesthetic problems. I, II; ½ to 2 units. Prerequisite: Architecture 417 or consent of instructor. BANNISTER, LAING.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Architectural Design.** Advanced problems in modern buildings and building groups with complex requirements. I, II; 2 units. Prerequisite: Architecture 236. LOVE.

338. **Architectural Design.** Terminal project (individual research and comprehensive architectural development). I, II; 2 units. Prerequisite: Architecture 337. LOVE.

339. **Urban Housing.** A study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. II; ½ unit. Prerequisite: Consent of instructor. RICHARDSON.

347. **Theory of Structures.** Advanced problems in the analysis of statically determinate structures, and general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. I, II; 1½ units. Prerequisite: Registration in Architecture 247 and Theoretical and Applied Mechanics 211. HORNBEAK.

348. **Advanced Structures.** Advanced topics on design of structural members and connection; analysis and design of continuous structures, rigid frames, and tall buildings. I, II; 1½ units. Prerequisite: Architecture 347; registration in Architecture 358. LINK.

358. **Reinforced Concrete Design.** Reinforced concrete building design. I, II; 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348. WANG.

ART

The Department of Art offers graduate work leading to the degrees of Master of Fine Arts (creative art) and Master of Arts (art education and art history). The prerequisite for graduate work leading to these degrees is the Bachelor of Fine Arts degree as established at this University with a concentration in the field to be pursued in graduate study, or its equivalent.

Students applying for admission must have a grade-point average of 3.5 based on that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Admission to the Graduate College does not make the student a candidate for an advanced degree in the department until he has been accepted as such by the departmental graduate committee. Upon application to the Graduate College, information on departmental procedures and requirements should be obtained by writing to the head of the Department of Art. Prospective students expecting to do graduate work leading to the Master of Fine Arts degree must submit original examples of their work to the departmental graduate committee in advance of registration. Students expecting to pursue study leading to the Master of Arts degree in art education must have or be eligible for a teaching certificate in their field. In order to determine eligibility for graduate study, prospective students must submit, for examination, a transcript of their undergraduate credits to the chairman of the department. In the event that a prospective candidate for any degree in the department is found to be deficient in any professional phase of undergraduate training, the committee will require the student to take such undergraduate courses as will remove the deficiency.

Not later than mid-point in the student's proposed program, the candidate is given a qualifying examination in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The committee may extend the residence requirement (or increase the total unit requirements) at this time or any other time, if this seems warranted. The student is recommended for the degree after a final review or examination.

The thesis required for the Master of Fine Arts degree is an original work of creative art, accompanied by a written report, while the thesis for the Master of Arts degree with a major in art history is a written document. The thesis remains the property of the University, as do such other works designated by the departmental graduate committee.

Degree of Master of Fine Arts with Design Major. To qualify for the degree of Master of Fine Arts, with a major in design, each student is required to complete satisfactorily all of the following courses to the minimum of twelve units: Art 491, one to three units; Art 493, one unit; Art 467 or 477, four to six units; art history (two courses elected from the group Art 311 through 318), one and one-half units; art electives (Art 323, 333, 341, 351, 355, 371, 372, 494, and art history), two or three units. A thesis is required.

Degree of Master of Fine Arts with Painting and Graphics Major. To qualify for the degree of Master of Fine Arts, with a major in painting and graphics, each student is required to complete satisfactorily all of the following courses to the minimum of twelve units: Art 341, one-half unit (substitution of credit in other courses may be made for this subject by permission of the departmental graduate committee); Art 491, one to three units; Art 493, one unit; Art 495, two to five units; Art 497, two to five units; art history (two courses elected from the group Art 311 through 318), one and one-half units; art electives (Art 323, 351, 371, 372, 494, and art history), one to two units. A thesis is required.

Degree of Master of Arts with Art Education Major. To qualify for the degree of Master of Arts, with a major in art education, each student is required to complete satisfactorily all of the following courses to the minimum of eight units: Art 493, one unit; art history (one course elected from the group Art 311 through 318), three-fourths unit; art electives, two and one-fourth units; Education 311, one-half unit; Education 312, one-half unit; Education 456, one unit; two of the following: Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required.

Degree of Master of Arts with Art History Major. To qualify for the degree of Master of Arts, with a major in art history, each student is required to complete satisfactorily all of the following courses to the minimum of eight units: Art 341, one-half unit; Art 493, one unit; Art 494, one to four units; art history (elected from the group Art 311 through 318), one and one-half to three units; electives, one or two units. A thesis is required.

ASSISTANTSHIPS

A limited number of assistantships are available. Applications should be made directly to the head of the department, 115 Architecture Building.

GRADUATE TEACHING FACULTY

Professors: J. R. Shipley (Head of Department), L. Bailey, C. A. Dietemann, C. V. Donovan, W. F. Doolittle, J. D. Hogan, J. W. Kennedy, F. J. Roos, H. A. Schultz, A. S. Weller.
Associate Professors: L. R. Chesney, M. B. Martin, E. C. Rae, N. Ziroli.
Assistant Professors: C. W. Briggs, R. A. Von Neumann.

COURSES FOR GRADUATES

467. **Advertising Design Laboratory.** Individually directed research in the studio with concentration in advertising design. I, II; 1 to 2 units. Prerequisite: Bachelor of Fine Arts degree in advertising design or equivalent. Donovan.

477. **Industrial Design Laboratory.** Individually directed research in the drafting room or workshop with concentration in industrial design. I, II; 1 to 2 units. Prerequisite: Bachelor of Fine Arts degree in industrial design or equivalent. Shipley.

491. **Special Problems.** Individual direction in research and in creative activity; thesis. I, II; 1 to 2 units. Staff.

493. **Seminar.** Introduction to methods of research and criticism. I; 1 unit. Roos, Weller.

494. **Studies in Art History and Criticism.** Individual study of special periods of art history; intensive reading of selected critical works; the writing of art criticism. I, II; 1 to 2 units. Rae, Roos, Weller.

495. **Painting Laboratory.** Professional and experimental painting with emphasis on the development of maturity of style and personal expression. I, II; 1 to 2 units. Staff.

497. **Graphics Workshop.** Intaglio printing, including etching, engraving, and aquatint. I, II; 1 to 2 units. Chesney.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Classical Art.** Architecture, painting, sculpture, and minor arts of the Greek and Roman periods. I or II; ¾ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

312. **Medieval Art.** Architecture, painting, sculpture, and minor arts of the Romanesque and Gothic periods. I or II; ¾ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

313. **Italian Renaissance Art.** Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. I or II; ¾ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Weller.

314. **Northern Renaissance Art.** Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. I or II; ¾ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Weller.

315. **Art of the Nineteenth Century.** Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. I or II; ¾ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

316. **Art of the Twentieth Century.** Architecture, painting, sculpture, and minor arts of the twentieth century in France, Germany, Spain, and England. I or II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

317. **American Art.** Architecture, painting, sculpture, and minor arts of the colonies and the United States. I or II; ¾ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

318. **Latin-American Art.** A study of the more important phases and periods of the visual arts of Latin America. II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

323. **Drawing.** Advanced drawing in several media. I, II; ½ to 1 unit. Prerequisite: Art 126 or equivalent. Briggs.

333. **Painting.** Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts degree in painting. I, II; ½ to 1 unit. Prerequisite: Art 142 or equivalent. Staff.

341. **Painting Materials and Techniques.** Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. I or II; ½ unit. Prerequisite: Art 142 or graduate standing in art. Kennedy.

351. **Advanced Sculpture Techniques.** Advanced work in various sculptural media. I, II; ½ to 1 unit. Prerequisite: Art 252 or equivalent. Martin.

355. **Graphic Media.** Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts degree in painting. I, II; ½ to 1 unit. Prerequisite: Art 256 or equivalent. CHESNEY.

371. **Silversmithing, I.** Advanced course in design and execution of hollow ware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. I, II; ½ unit. Prerequisite: Art 172 or equivalent. VON NEUMANN.

372. **Silversmithing, II.** Advanced course in design and execution of flatware and hollow ware, dealing primarily with forging and seaming methods, engraving, and toolmaking. I, II; ½ unit. Prerequisite: Art 371. VON NEUMANN.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the degree of Master of Science in the theoretical aspects of astronomy. The admission requirements for graduate study in astronomy are the general regulations governing admission of all graduate students, a major in either mathematics or physics, and a year's course in descriptive astronomy, e.g., Astronomy 201 and 202. The eight units required for the degree of Master of Science are to be secured in the following way: (1) two units may be obtained by selecting one out of the following pairs of courses in mathematics: 341 and 342, 343 and 345, 458 and 459; (2) two units may be obtained by selecting one out of the following three pairs of courses in physics: 321 and 322, 371 and 381, 400 and 422; (3) the remaining units are to be obtained by selection from the courses in astronomy listed below.

For information concerning applied mathematics, see page 28.

GRADUATE TEACHING FACULTY

Professor: G. C. MCVITTIE (Head of Department).
Assistant Professor: S. P. WYATT.

COURSES FOR GRADUATES

404. **Theory of Stellar Structure.** Mathematical theory of the internal equilibrium of a gaseous star under the action of gravity, gas pressure, and radiation pressure; types of stars; source of stellar energy. I or II; 1 unit. Prerequisite: Consent of instructor. MCVITTIE.

424. **Relativity and Cosmology.** Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. MCVITTIE.

464. **Dynamics of the Earth's Atmosphere.** Same as Mathematics 464 and Physics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. MCVITTIE.

491. **Seminar in Special Topics.** I or II; 1 to 4 units. Prerequisite: Consent of instructor. MCVITTIE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introductory Astrophysics.** Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interiors;

special types of stars, interstellar matter. I or II; 1 unit. Prerequisite: Physics 108.

306. **Foundations of Mechanics and Gravitational Theory.** Same as Aeronautical Engineering 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to earth, precession of earth's axis, etc. I or II; 1 unit. Prerequisite: Mathematics 142 or 143. McVittie.

307. **Celestial Mechanics.** Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. I or II; 1 unit. Prerequisite: Astronomy 306 or Physics 322. McVittie.

314. **Observational Astronomy.** Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. II; 1 unit. Prerequisite: Astronomy 201 and 202; Mathematics 142 or 143. Wyatt.

321. **Galactic Structure and Dynamics.** Observational data on the distribution of stars in space; stellar statistics; stars in solar neighborhood; space-density analyses; galactic rotation; stellar populations and their distributions. I or II; 1 unit. Prerequisite: Astronomy 202; Astronomy 306 or Physics 322.

BACTERIOLOGY

The Department of Bacteriology offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. Students electing bacteriology as a major for an advanced degree must have had, in addition to formal training in general bacteriology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these course requirements may apply for admission if they have a grade-point average of at least 4.0 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Candidates for the degree of Master of Science must pass a general written comprehensive examination toward the close of the second semester of residence.

ASSISTANTSHIPS

There are a number of teaching assistantships available to graduate students in bacteriology. Some research assistantships and industrial fellowships are available in the department. These are generally awarded to students who have been enrolled in graduate work in the Department of Bacteriology for one or more years. Applications for assistantships should be made to the head of the department, 362 Noyes Laboratory.

GRADUATE TEACHING FACULTY

Professors: H. O. Halvorson (Head of Department), S. E. Luria, S. Spiegelman, G. I. Wallace.
Associate Professor: F. M. Clark.
Assistant Professors: E. Juni, R. S. Wolfe.

COURSES FOR GRADUATES

404. **Quantitative Analysis of Bacteriological Procedures.** Quantitative analysis of counting methods, antibiotic assay methods, vitamin assay methods, analysis of growth and death curves, methods of measuring mutation frequency, and quantitative aspects of epidemiology. I; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Bacteriology 300 and 306. HALVORSON, SPIEGELMAN.

405. **Microbiological Genetics.** Study of the phenomenon of heredity in microorganisms with particular reference to recent developments in the field. Examples from protozoa, yeasts, molds, bacteria, and viruses are considered. Emphasis is placed on critical examination and evaluation of methods. Implications of results for fundamental aspects of gene functions are considered. II; ¾ unit. Prerequisite: Genetics (Botany 322 or Zoology 351); Bacteriology 404; mathematics through calculus, or consent of instructor. SPIEGELMAN.

420. **Chemistry of Microbic Processes.** The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimilation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. I; ¾ unit. Prerequisite: Bacteriology 300 and Chemistry 234 and 350, or equivalent; consent of instructor.

425. **Bacterial Metabolism.** Laboratory. Designed to give a working knowledge of the methods currently employed in the study of the chemical aspects of microorganisms. Experiments include the analysis of fermentation mixtures, the metabolic properties of microorganisms and the enzymes involved as illustrated with resting cells, cell preparations, and cell-free enzymes. The application of manometric, colorimetric, and isotopic methods to the study of microorganisms and the purification of microbic enzymes are included. I; ¾ unit. Prerequisite: Bacteriology 420.

451. **Experimental Virology.** Experiments to illustrate the main properties of viruses. II; ¾ unit. Prerequisite: Credit or registration in Bacteriology 351; consent of instructor. LURIA.

490. **Research.** I, II; ½ to 4 units. STAFF.

495. **Seminar.** Required of all graduate students whose major is bacteriology. I, II; 0 to ¼ unit. Prerequisite: Ten hours of bacteriology; consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Microbiology.** Emphasis is placed on the fundamental concepts and techniques of microbiology; isolation, cultivation, and observation of bacteria. The morphology, physiology, and nutrition of microorganisms; their role in nature, and infection and immunity are considered. I, II; 1 unit. Prerequisite: A college course in general botany or zoology; chemistry through organic. JUNI.

306. **Principles of Experimental Bacteriology.** A study of the experimental basis of bacterial physiology, cytochemistry, and variation; the conditions which influence metabolism, growth, and death; the properties of the bacterial cell and the bacterial culture. Laboratory experiments are designed to illustrate the principles of experimentation as applied to microorganisms. I; 1 unit. Prerequisite: Bacteriology 300; Chemistry 124 and 234, or equivalent. LURIA, WOLFE.

308. **Food and Industrial Microbiology.** The relationship of microorganisms to food manufacture and preservation, and to industrial fermentation and processing. The laboratory considers the properties of the bacteria, yeasts, molds, and actinomyces of importance to industrial processes and methods of control. Lecture and laboratory. I; 1 unit. Prerequisite: Bacteriology 104 or 300. CLARK, HALVORSON.

309. **Nutrition and Cultivation of Microorganisms.** Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, cultivation of bacteria, and microbiological assays. II; 1 unit. Prerequisite: Bacteriology 104 or 300; chemistry through quantitative analysis and organic. WOLFE.

326. **Pathogenic Bacteriology.** A study of the pathogenic bacteria: classification, morphology, cultural requirements, and reactions; toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lecture and laboratory. I; 1 unit. Prerequisite: Bacteriology 104 or 300. WALLACE.

327. **Immunology and Serology.** A survey of the field of immunology; prevention of disease, diagnosis, and preparation and use of biologicals in the treatment of disease. Lecture and laboratory. II; 1 unit. Prerequisite: Bacteriology 104 or 300. WALLACE.

351. **Viruses.** The study of filterable viruses as a branch of microbiology: statistical, physical, and chemical properties of virus particles; analysis of host-virus interaction; origin and natural relations of viruses. II; ¾ unit. Prerequisite: Bacteriology 300 or equivalent. LURIA.

BIOLOGICAL SCIENCES

Through the Division of the Biological Sciences (including bacteriology, botany, entomology, physiology, psychology, zoology) it is possible to arrange a program leading to the degree of Master of Science in the Biological Sciences. Students seeking admission to this division must have a grade-point average of 3.5 for that portion of the work which represents the last 50 per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

While the main emphasis is on botany and zoology, the candidate must have at least one unit in each of the following subjects: bacteriology, botany, entomology, physiology, and zoology. One unit in psychology (other than educational psychology) is strongly recommended. In planning his course of study the candidate should give less emphasis to subjects in which he has already had considerable training. At least one unit must be taken in courses of graduate grade (courses numbered 400 and above). A thesis is not required, but at least one course should be included in which individual problems are assigned. The chairman of the Division of Biological Sciences is Professor H. O. Halvorson, 361 Noyes Laboratory.

Candidates for the degree of Master of Science in the Teaching of the Biological Sciences and General Science must earn four units in biological sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in the biological sciences and the electives must be selected with the approval of the adviser. The electives may be in the biological sciences, in education, or, in exceptional cases, in other fields. A course in biological chemistry and one in experimental psychology are strongly advised. The adviser for candidates for this degree is Professor H. J. Fuller, 203 Natural History Building.

Students wishing to combine training for research in biology with graduate work in physics and chemistry may be interested in the curriculum offered under physico-chemical biology (page 233).

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

331. **Physico-Chemical Biology, Part I: Radiobiology.** Same as Physiology 331. Action of ionizing radiations on living organisms. I or II; 1 unit. Prerequisite: One year each of biology, physics, chemistry, and mathematics.

332. **Physico-Chemical Biology, Part II: Photobiology.** Same as Botany 332. Lecture and seminar course dealing with interaction of light and living matter (photosynthesis, phototropism, photoperiodism, vision, bioluminescence). I or II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: One year of physics, chemistry, and biology; consent of instructor. RABINOWITCH.

333. **Physico-Chemical Biology, Part III: Electrobiology.** Same as Botany 333 and Physiology 333. Potentials produced by and effects of potentials upon living organisms. Lectures, student reports, and demonstrations. I or II; ¾ unit. Prerequisite: Ten hours of biology; four hours of physical chemistry; ten hours of physics. PROSSER.

BOTANY

The Department of Botany offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. Candidates for advanced degrees must have had at least twenty hours of undergraduate work in botany, or fifteen hours in botany and five hours in a related subject acceptable to the department. Admission to graduate work in the department is contingent upon satisfaction of admission requirements of the Graduate College which are described in the general introductory section of this catalog. Specifically, the applicant's grade-point average for that portion of work which represents the last 50 per cent of the hours completed toward the bachelor's degree, exclusive of physical education and military training, must be at least 3.5. Students are not admitted on limited status.

Graduate students who elect botany as a minor field must fulfill the general requirements of the Graduate College for completion of graduate minors and should determine their course requirements in consultation with the chairman of the Department of Botany.

The following fields of botany are available for specialization within the department: anatomy, cytogenetics, cytotaxonomy, ecology, mycology, paleobotany, phycology, physiological genetics, physiology (including photosynthesis), plant geography, taxonomy, and virology.

Attention is called to courses offered in the Departments of Agronomy, Bacteriology, Chemistry, Entomology, Geography, Geology, Horticulture, Mathematics, Physics, Physiology, Plant Pathology, and Zoology, which are available to advanced students and offer a broad foundation for botanical work. Graduate students in botany may elect their minor subjects in one or two of these fields.

Graduate students may avail themselves of the University herbarium which contains 350,000 specimens of vascular plants, bryophytes, algae, fungi, and fossil plants. As field laboratories, the University maintains two tracts of woodland, Brownfield Woods and Trelease Woods; in addition, certain areas of Robert Allerton Park in Monticello have been designated for research and study. Several ranges of greenhouses are maintained for experimental work with living plants and laboratories well equipped for research in plant physiology, including exceptional facilities for studies of photosynthesis, are available to students in these fields. Laboratory and greenhouse facilities for research in genetics, my-

cology, paleobotany, and plant virology have been expanded recently and are completely equipped. The Maize Genetics Research Laboratory maintains an extensive collection of maize genetic stocks adapted to the North Central States; the College of Agriculture and the Agricultural Experiment Station offer exceptional facilities to graduate students in plant genetics, plant pathology, and in some others of the plant sciences. The Natural History Library, with over 70,000 volumes, offers excellent library facilities, with bibliographical aids, including the Gray Herbarium Card Index of American Plants, the Index of American Botanical Literature of the Torrey Botanical Club, and the Tilden Index Algarum Universalis. The University also maintains such facilities as electron microscopes, electronic computer, betatron, ultracentrifuge, and a radiocarbon laboratory for use in tracer studies.

Degree of Master of Science. During their graduate work or as advanced undergraduates, candidates for this degree must have completed courses in the following basic fields of botany: (1) taxonomy (Botany 360 or equivalent), (2) morphology (Botany 302 and 303, or equivalent), (3) ecology or plant geography (Botany 381, or 385 or 386, or equivalent), (4) genetics (Botany 322 or equivalent), (5) physiology (Botany 130 or equivalent).

A thesis is not required of candidates for the Master of Science degree except at the option of the graduate student's major adviser. Graduate students do not receive credit in research courses toward the master's degree unless they write acceptable master's theses. The master's degree is not prerequisite to work toward the doctorate; that is, a student may engage in graduate work toward the Doctor of Philosophy degree without having obtained a master's degree.

Degree of Doctor of Philosophy. Candidates for this degree must complete the course requirements listed above before receiving the Doctor of Philosophy degree. Students who commence their graduate work at the University of Illinois ordinarily complete these requirements during their first year of graduate study. Students who enter upon graduate work toward the doctor's degree at the University of Illinois after having received the master's degree from some other university, or after having completed some graduate work at another university, are required to complete any of the above-listed courses which they may not have had. Having satisfied these basic course requirements, the candidate for the doctor's degree may elect whatever other graduate courses he desires, subject to the approval of his major professor and to the general regulations of the Graduate College concerning requirements in his major and minor fields (see the general introductory section of this catalog).

All candidates for the Doctor of Philosophy degree in botany must pass a qualifying examination in the above-listed basic fields of botany, the purpose of which is to determine whether the student is qualified to pursue further work toward the degree and to provide a basis for recommending a program of study in those areas in which he may be deficient. This examination is administered as a written examination to be taken by all doctorate candidates within one year after initiation of their studies at the University of Illinois. Qualifying examinations are given in the fall and in the spring in accordance with a schedule set by the botany faculty.

After the candidate has passed the departmental qualifying examination and the two foreign language examinations and has satisfactorily completed at least sixteen units of graduate work, he may be admitted to the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College and is designed to test the candidate's knowledge of the fields of his major and minor subjects. Upon completion of the doctoral thesis, a final oral examination, concerned primarily with the student's research and administered by a committee appointed by the Dean of the Graduate College, is given at least two weeks before the degree is conferred.

Master's and doctor's theses are due in the office of the Department of Botany ten days before they are due in the Graduate College office. During this period theses are available for reading by faculty members who may suggest changes in them before they are delivered to the Dean of the Graduate College. Graduate theses must be prepared in accordance with "Instructions for Preparation of Theses," a publication available in the Graduate College office.

Students are expected to secure a broad background in the whole field of botany, as well as in general biological principles. This may be achieved in part by courses, but an essential adjunct to the acquisition of this background is a program of reading and individual study. The following may be cited as examples of topics which students are expected to study privately: history of botany, philosophy of science (attention is directed to Philosophy 328, a course in philosophy of science), and latest developments in various fields of botany. As an aid in this study, students are advised to join a plant science society and to subscribe to a botanical journal. Further, students should form the habit of examining botanical journals as these appear in the library so that they become familiar with them and with current research. They should become acquainted with Biological Abstracts, the Botanical Review, and other summarizing journals. The student's adviser in a special branch of botany recommends, in addition to those courses required of all candidates, other courses to fit the student's special needs in his research field and allied subjects. Thus a student in physiology may be advised to complete certain courses in chemistry and physics, and a student in morphology or taxonomy may be instructed to complete certain courses in geology.

Students desiring to obtain a master's degree preparatory to high school teaching should register in the graduate teacher-training curriculum leading to the Master of Science degree in the Teaching of Biological Sciences and General Science (see page 64). The adviser for candidates for this degree is Professor H. J. Fuller, 203 Natural History Building.

Opportunities for biophysical research are available in the Botany Department in an interdepartmental curriculum leading to the Doctor of Philosophy degree in Physico-Chemical Biology, and requiring a combined training in physics, chemistry, and biology.

FELLOWSHIPS AND ASSISTANTSHIPS

Financial support of graduate study is provided by fellowships, teaching assistantships, and research assistantships. Fellowships are awarded by the Graduate College to superior students. Stipends are $1,200 an academic year.

Teaching assistantships are chiefly on a half-time basis at a stipend of $1,500 for two semesters. Half-time teaching assistants spend approximately ten hours a week in teaching or related duties.

Research assistantships are available in small numbers to graduate students at an advanced level and provide a stipend of $1,500 for half-time appointments for two semesters. Half-time research assistants devote approximately twenty hours a week to supervised research.

For further information concerning fellowships, teaching assistantships, and research assistantships, refer to the general introductory section of this catalog. To obtain application blanks for teaching or research assistantships, address the chairman of the Department of Botany, 208 Natural History Building.

GRADUATE TEACHING FACULTY

Professors: J. R. Lauchnan (Chairman of Department), L. M. Black, R. Emerson, H. J. Fuller, G. N. Jones, E. I. Rabinowitch, M. M. Rhoades, L. Shanor, A. G. Vestal.

Associate Professors: J. F. Nance, W. N. Stewart.
Assistant Professor: P. C. Silva.
Instructors: L. R. Heckard, D. M. Post.

COURSES FOR GRADUATES

402. **Physiological Genetics.** The probable nature of the gene and its action as deduced from studies on chromosome chemistry, genetically controlled reactions, cytoplasmic inheritance, mutation and gene analogues, with emphasis on higher plants and fungi. II; ½ or 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Botany 322 or equivalent. Laughnan.

403. **Physiology of Fungi.** Same as Plant Pathology 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. I; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Organic or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

410. **Botanical Discussions.** Required of all graduate students in botany. I, II; 0 to ¼ unit.

411. **Discussions in Genetics and Cytogenetics.** Same as Zoology 411. I, II; ¼ unit. Kitzmiller, Laughnan, Luce, Rhoades.

413. **Discussions in Plant Physiology.** I; ¼ unit. Fuller, Nance.

414. **Discussions in Plant Morphology and Taxonomy.** I, II; ¼ unit. Heckard, Jones, Post, Silva, Stewart.

418. **Discussions in Plant Ecology and Plant Geography.** Developments in ecology and plant geography, with emphasis on one special division. II; ¼ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. Vestal.

419. **Discussions in Photosynthesis and Related Topics.** I, II; ¼ unit. Prerequisite: Consent of instructor. Emerson, Rabinowitch.

420. **Cytogenetics.** An advanced course in which emphasis is placed on the correlation of genetic data with chromosomal aberrations. I; 1 unit. Prerequisite: Botany 320 and 322, or equivalent. Rhoades.

427. **Discussions in Mycology.** A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. I, II; ¼ unit. Prerequisite: Consent of instructor. Shanor.

433. **Advanced Physiology of Growth, Responses, and Reproduction.** I; 1 unit. Prerequisite: Botany 130 or equivalent. Fuller.

471. **Advanced Mycology: Special Groups.** Special groups of fungi and their activities are considered. Different groups for concentrated study may be selected each semester depending upon the student's interest in mycology. I, II; ½ unit. Prerequisite: Consent of instructor. Shanor.

472. **Industrial Mycology.** The characteristics, relationships, and activities of fungi of industrial importance are considered. Yeasts and mushrooms are included but major emphasis is placed on Mucorales, Aspergilli, Penicillia, and Fungi Imperfecti. I; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Consent of instructor. Shanor.

493. **Research.** I, II; ½ to 4 units. Work may be taken in the following fields, subject to approval of one of the staff:

(a) **Plant Morphology.** Post, Silva, Stewart.
(b) **Plant Physiology.** Fuller, Nance.
(c) **Taxonomy of Vascular Plants and Bryophytes.** Jones.

(d) **Mycology.** SHANOR.
(e) **Plant Virology.** (Same as Plant Pathology 492.) BLACK.
(f) **Plant Ecology or Plant Geography.** VESTAL.
(g) **Plant Anatomy.** POST.
(h) **Photosynthesis.** EMERSON, RABINOWITCH.
(i) **Genetics and Cytogenetics.** LAUGHNAN, RHOADES.
(j) **Paleobotany.** STEWART.
(k) **Phycology.** SILVA.
(l) **Cytotaxonomy.** HECKARD.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Individual Topics.** For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degree. I, II; ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. STAFF.

302. **Comparative Morphology: Nonvascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, and bryophytes. Students receiving credit for Botany 302 do not receive credit for Botany 304. I; ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 or 132, or equivalent. SHANOR, SILVA, STEWART.

303. **Comparative Morphology: Vascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative vascular plants, including psilopsids, lycopsids, sphenopsids, ferns, gymnosperms, and angiosperms. Students receiving credit for Botany 303 do not receive credit for Botany 304. II; ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. HECKARD, POST, STEWART.

304. **General Plant Morphology.** A survey of the principles of plant morphology as exemplified by the various plant groups. Designed primarily for high school and college teachers who are summer session students. Students receiving credit for Botany 304 do not receive credit for Botany 302 or 303. S; ½ or 1 unit. Offered in 1956 and in alternate years. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. STEWART.

306. **Biology for Teachers.** Same as Zoology 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. In order to make possible out-of-town practice teaching, this course is completed during the first six weeks of the semester. II; ¼ or ½ unit. Prerequisite: Botany 100 and Zoology 101 or 104, or a year course in general biology. FULLER, MATTESON.

317. **Plant Pathology.** Same as Plant Pathology 317. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science, including Botany 100. BLACK.

320. **Cytology.** Study of nuclear and cell division, with emphasis on chromosome structure and behavior. Various aspects of cytological behavior are considered in relation to genetics and development. II; 1 unit. Prerequisite: One year of botany. RHOADES.

322. **Genetics.** A basic treatment of the facts and fundamental principles of genetics, with special emphasis on plants. I; 1 unit. Prerequisite: One year of botany. LAUGHNAN.

325. **Paleobotany.** Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. II; ½

or 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor. STEWART.

332. **Physico-Chemical Biology, Part II: Photobiology.** Same as Biological Sciences 332. Lecture and seminar course dealing with interaction of light and living matter (photosynthesis, phototropism, photoperiodism, vision, bioluminescence). I or II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: One year of physics, chemistry, and biology; consent of instructor. RABINOWITCH.

333. **Physico-Chemical Biology, Part III: Electrobiology.** Same as Biological Sciences 333 and Physiology 333. Potentials produced by, and effects of potentials upon, living organisms. Lectures, student reports, and demonstrations. I or II; ¾ unit. Prerequisite: Ten hours of biology; four hours of physical chemistry; ten hours of physics. PROSSER.

335. **Plant Physiology: Metabolic Transformations.** II; ½ or 1 unit. Prerequisite: One year of botany, including Botany 130; one year of chemistry. NANCE.

340. **Histological Technic.** Survey of technics used in the preparation of plant tissues for microscopical examination. II; ½ or 1 unit. Prerequisite: One year of botany or ten hours of zoology. POST.

345. **Plant Anatomy.** Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. I; ½ or 1 unit. Prerequisite: One year of botany. POST.

350. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology of algae. II; ½ or 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. SILVA.

360. **Advanced Taxonomy of Flowering Plants.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. I; ½ or 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Botany 160 or one year of botany or another biological science, or consent of instructor. JONES.

366. **Field Botany.** Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. JONES.

372. **General Mycology.** Structure, classification, and identification of fungi, including those of economic importance. Modification of the course is made to meet the needs of teachers and prospective teachers during the summer. II; 1 unit. Prerequisite: One year of botany, bacteriology, entomology, or zoology. SHANOR.

379. **Research Methods in Plant Pathology.** Same as Plant Pathology 379. Techniques for the isolation, identification, culture of and inoculation with plant pathogens; methods for the histological study of diseased plants; recording of data. I; ½ unit. Prerequisite: Botany 317. GERDEMANN.

380. **Field and Forest Ecology.** Outdoor biology, primarily for teachers, based on prairie and forest vegetation in Illinois. One two-day and two one-day field trips are included. Students receiving credit for Botany 380 do not receive credit for Botany 381. S; 1 unit. Offered in 1956 and in alternate years. Prerequisite: One course in botany. VESTAL.

381. **Plant Ecology.** Principles of ecology, exemplified by vegetation and environments of Illinois. Students receiving credit for Botany 381 do not receive credit for Botany 380. I; ½ unit. Prerequisite: One year of botany. VESTAL.

385. **Plant Geography of North America.** Vegetation regions and principal subdivisions; environments, plant cover, floras. I; ½ or 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: One year of botany. VESTAL.

386. **Plant Geography of Continents Other Than North America.** Regions, vegetation-types, notable species. I; ½ or 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: One year of botany. VESTAL.

388. **Ecology: Plant Communities.** Characteristics, types, development, and classification of communities. II; ½ or 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: One year of botany, including Botany 280 or 381. VESTAL.

BUSINESS

The degree of Doctor of Philosophy in Business is awarded to those who complete the subject-matter requirements listed below and the general requirements named in the forepart of this catalog. The subject-matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Students lacking adequate preparation for admission may be admitted with the consent of the adviser or committee in charge, but must remove any deficiencies during the first year of residence by taking prescribed courses without credit toward the advanced degree. Those candidates who hold a master's degree in economics or business can usually complete the requirements in two years by appropriate synchronization of courses previously taken with those offered in this program.

In lieu of the provisions on major and minor subjects on page 24, candidates for the Doctor of Philosophy degree in Business prepare themselves for examination in five fields, including management, marketing, and economic theory. At least two other fields must be selected, one of which (two units) may be outside the College of Commerce and Business Administration if approved by the adviser. For numbers and titles of courses available, see the courses listed in this catalog under Accountancy, Economics, Management, and Marketing.

Inasmuch as the major fields for this degree cross departmental lines, administration of the work is in the hands of a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the chairman of the Committee on the Doctor of Philosophy Degree in Business, 411 David Kinley Hall.

BUSINESS EDUCATION

The Department of Business Education offers graduate work leading to the degree of Master of Science in Commercial Teaching. The work is part of an integrated five-year program for those preparing to become commercial teachers. The detailed requirements of the four-year curriculum are given in the bulletin on Undergraduate Study. The requirements of the fifth year are based on the educational background of the first four years. Students may also take advanced degree programs in education specializing in business education.

Students seeking admission in any area must have a grade-point average of 3.5 for that portion of the work which represents the last 50 per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. Only a limited number of the requirements listed below may be completed by extramural graduate study. Questions related to extramural courses should be referred to the appropriate graduate adviser.

Candidates for the degree of Master of Science in Commercial Teaching must earn three units in education, consisting of the courses listed in Group 1 below; three units in commerce, consisting of two units from courses listed in Group 2 below and one unit from courses listed in Group 3 below (business education); and two units of electives. All courses must be selected with the approval of the student's adviser.

(1) Education. Three units consisting of Education 311, 312, 456, and two of the following: Education 301, 302, 303, 304.

(2) Commerce (other than business education). Two units selected from Accountancy 308, 371, 401, 427; Business Law 301; Economics 312, 326, 328, 378, 384, 388, 400, 414, 415, 436, 440, 441; Management 312; Marketing 315, 372, 373, 387, 401, 415, 421, 481.

(3) Commerce (business education). One unit selected from Business Education 351, 352, 353, 361, 382, 383, 491.

(4) Recommended Electives. Two units selected from courses listed under (1) and (2), or not more than one unit from (3), or from courses in the following list: Education 354, 381, 390, 391, 401, 411, 413, 422, 423, 425, 428, 439, 460; Journalism 308; Rhetoric 351. These courses are suggestions only; others may be taken with the consent of the adviser.

The adviser for candidates for this degree is Professor Arnold C. Condon, 9 David Kinley Hall.

ASSISTANTSHIPS

Teaching assistantships are occasionally available for highly recommended candidates for any of the graduate degrees ordinarily taken by business teachers. For information write the head of the department.

GRADUATE TEACHING FACULTY

Professor: A. C. Condon (Head of Department).
Associate Professor: Elizabeth R. Melson.
Assistant Professors: F. L. Crank, R. E. Mason, Mildred E. Reed.

COURSES FOR GRADUATES

491. Thesis. I, II; ½ to 2 units. Condon.

Note: See also Education 456 and 459.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. **Improvement of Instruction in Shorthand.** A study of the history, principles, and practices of shorthand instruction, including evaluation of literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including Business Education 112; sixteen hours in education, including Education 242. Condon, Reed.

352. **Improvement of Instruction in Typewriting.** A study of the history, principles, and practices of typewriting instruction, including evaluation of literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including Business Education 203; sixteen hours in education, including Education 242. Melson, Reed.

353. **Improvement of Instruction in Bookkeeping.** A study of the history, principles, and practices of bookkeeping instruction, including evaluation of

literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including six hours in accountancy; sixteen hours in education, including Education 242. MASON.

361. **Teaching Office Management and Machine Operations.** Designed for high school and college teachers. Selection and use of machines, course content for machine courses, and organization of instructional material. S; ½ unit. Prerequisite: Education 241, 242; sixteen hours in commerce, six of which must be in accountancy; one year of teaching experience. MELSON.

382. **Organization and Administration of Cooperative Part-Time Programs in Business Education.** Deals with background, aims, coordination techniques, and administrative policies for organizing and operating cooperative part-time programs in distributive and office occupations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce; consent of instructor. MASON.

383. **Problems in Cooperative Education.** Students apply for and secure distributive or office positions with selected cooperating business firms. While regularly employed in these supervised positons, they observe the relationships between those activities and the cooperative business education programs in the high school. These relationships are pointed up through regularly scheduled class meetings where emphasis is placed on job analysis, current trends, wage and benefit structure, personnel practices, and labor relations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce. MASON.

BUSINESS LAW

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE TEACHING FACULTY

Professors: E. R. DILLAVOU (Head of Department), P. C. ROBERTS.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Business Torts.** Liability of businessmen for their wrongful acts, and those of their agents arising separate and apart from their liabilities under contracts; covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, inducing breach of contract. II; ¾ to 1 unit. Prerequisite: Business Law 100, 201, 202, or 261.

301. **The Law of Security Transactions and Banking.** Significant phases of law in the fields of pledges, chattel mortgages, conditional sales, suretyship, insurance, real property, banks and banking, and bankruptcy. Under real property, real estate mortgages, landlord and tenant and mechanics liens are considered as well as the general principles of real property. I, II; ½ to 1 unit. Prerequisite: Business Law 100 or credit or registration in Business Law 202. DILLAVOU.

302. **Wills, Estates, and Trusts.** A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. I; ½ to 1 unit. Prerequisite: Business Law 100 or credit or registration in Business Law 202. ROBERTS.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers graduate work leading to the degrees of Master of Science in Ceramics, Master of Science in Ceramic Engineering, Doctor of Philosophy in Ceramics, and Doctor of Philosophy in Engineering.

The prerequisite for a major in graduate work in ceramics or ceramic engineering is proficiency in the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired, or substantial equivalents. An applicant's undergraduate grade-point average must be at least 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Candidates for the degree of Doctor of Philosophy in Ceramics must have had the equivalent of at least twenty-five semester hours of satisfactory courses in general, analytical, physical, and organic chemistry; also calculus, one year of college physics, and at least eighteen semester hours or their equivalent in acceptable ceramic courses.

Students with bachelor's degrees in chemistry, physics, or engineering may become candidates for the Master of Science or Doctor of Philosophy degrees but must make up deficiencies in ceramics by taking undergraduate courses at reduced graduate credit. The student must, however, always be registered in at least one unit of graduate work.

The fields for majoring in ceramics or ceramic engineering are refractories, porcelain enamels, glass, whitewares, structural clay products, and materials. The most common minors selected by graduate students in ceramic engineering are chemistry, physics, metallurgy, mathematics, geology, and engineering. A first minor may, however, be taken in the Department of Ceramic Engineering.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramic prerequisite.

FELLOWSHIPS

The following Graduate College fellowships are available in ceramic engineering: Ferro Corporation Fellowship; Edward Orton, Jr. Fellowship; Owens-Illinois Fellowship; Titanium Alloy Division of National Lead Company Fellowship.

GRADUATE TEACHING FACULTY

Professors: A. I. Andrews (Head of Department), R. L. Cook, F. V. Tooley.

Associate Professors: A. W. Allen, A. L. Friedberg.

COURSES FOR GRADUATES

401. **Ceramic Chemistry.** Silica, silicates, fusions, and phase relations. I; 1 unit. Prerequisite: Courses in chemistry and physics. Andrews.

402. **Ceramics.** Chemical and physical phenomena. II; 1 to 2 units. Prerequisite: Courses in physics and chemistry. Andrews.

403. **Drying.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 203 or equivalent.

404. **Firing.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 204 or equivalent.

405. **Glass Technology.** This course, designed for ceramic engineering graduates, is required for students majoring in glass technology and may be elected by

students majoring in some other branch of ceramic engineering. The course is concerned with the study of the properties of glass of importance in manufacturing and end use; emphasis is placed equally on research, control, development, and production aspects of the subject. I; 1 unit. Prerequisite: Ceramic Engineering 214 and 217, or equivalent. TOOLEY.

406. **Glass Technology.** This course, designed for ceramic engineering graduates, is required for students majoring in glass technology and may be elected by students majoring in some other branch of ceramic engineering. The course includes comprehensive literature surveys on selected topics and seminar type reports on classical researches in glass technology. Emphasis tends to the research point of view. II; 1 unit. Prerequisite: Ceramic Engineering 214 and 217, or equivalent. TOOLEY.

407. **Porcelain Enamels.** Advanced study in the composition, properties, and processing of porcelain enamels. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 222 and 223, or equivalent. ANDREWS.

408. **Refractories.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 218 or equivalent. ALLEN.

409. **Special Ceramic Bodies and Glazes.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 211 or equivalent. COOK.

491. **Thesis.** Research in any of the branches of ceramics. I, II; 1 to 4 units. ALLEN, ANDREWS, COOK, TOOLEY.

495. **Materials and Special Problems.** Conference and laboratory. I or II; 1 to 2 units. ALLEN, ANDREWS, COOK, TOOLEY.

CHEMISTRY AND CHEMICAL ENGINEERING

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering.

Students who have fulfilled the undergraduate course requirements as specified below may apply for entrance to the Graduate College in chemistry or chemical engineering if they have a grade-point average of 4.0 for that portion of undergraduate work representing the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required hygiene, physical education, and military training. Students are not admitted on limited status.

Students who have completed graduate work in chemistry or chemical engineering and related subjects at another institution may be admitted provided their undergraduate records meet the above requirements, and their grade-point averages in graduate work are at least 4.0. Students whose undergraduate records have not met the above requirements must have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution in order to be admitted to the Graduate College in chemistry and chemical engineering.

All students who receive permits to enter the Graduate College in chemistry or chemical engineering, regardless of whether they have had training beyond the bachelor's degree, must take registration examinations. These are offered in the week prior to the opening of the first semester for those entering in the fall, in the week prior to the opening of the second semester for those entering in February, and in the week prior to the opening of the summer session for those entering at that time. Those who intend to major in any field of chemistry must take four examinations covering the normal undergraduate instruction in inorganic, analytical, organic, and physical chemistry. Those who intend to specialize in chemical engineering must take two of the examinations in chemistry, one of which must be physical chemistry and the other of the student's own selection;

and, in addition, two in chemical engineering covering the usual undergraduate instruction in that subject. The results of these registration examinations are not permanently recorded but serve merely to assist in the registration of students in the proper graduate courses. Students who are deficient are required to register in one or more specific courses before taking more advanced work in a particular field. Most of these courses allow graduate residence credit. Students who have received permits to enter the Graduate College in chemistry or chemical engineering should contact the department immediately to learn the dates when these registration examinations are given and to obtain any other detailed information desired.

Students who are candidates for admission to the Graduate College in chemistry or chemical engineering must have had the equivalent of twenty-five semester hours in chemistry properly distributed.

Students who intend to take graduate work for an advanced degree in chemistry or chemical engineering should include in their undergraduate preparation at least the equivalent of one full year of physics, one year of French, one year of German and mathematics through differential and integral calculus. Any student without the necessary physics or mathematics may enter the Graduate College but is required to spend part of his time in residence to remove the deficiency.

A language is not required for students entering the Graduate College in chemical engineering. In order to be admitted as a candidate for an advanced degree in chemistry a student must have had one year of college French or German (preferably German). Where the applicant has done two or three years of work in French or German in secondary school, the requirement is considered to be met, provided at least one semester of the language more advanced than his secondary school work has been done in college. Four years of French or German completed in a secondary school are accepted in lieu of any college work in the subject. An applicant who has a knowledge of French or German but who lacks formal credentials may be examined to determine his language status. Such an applicant should correspond with the Dean of Admissions with reference to his examination.

In meeting the language requirements for the degree of Doctor of Philosophy in Chemistry or Chemical Engineering, a student may substitute Russian for French on the direct recommendation of the Department of Chemistry and Chemical Engineering (and without formal petition), provided such recommendation is approved by the Dean of the Graduate College.

Candidates for the Master of Arts or Master of Science degree with a major in chemistry or chemical engineering must include among their courses Chemistry 342 and 343 or the equivalent.

Candidates for the Doctor of Philosophy degree in any branch of chemistry or chemical engineering must include among their courses Chemistry 342, 343, 344, and 345 or the equivalent.

Before taking chemistry or chemical engineering courses for graduate credit, graduate students whose major subject is in some department other than chemistry and chemical engineering must have had the equivalent of fifteen semester hours in chemistry, including satisfactory work in general chemistry, qualitative and quantitative analysis, and elementary organic chemistry. Such students are advised to make selections from the following courses: Chemistry 315, 316, 327, 329, 336, 337, 342, 343, 344, 345, 350, and 355. Courses of a more special nature are not, as a rule, accepted for graduate work unless preceded by one or more of the above courses.

Students majoring in other departments who desire a sole minor in chemistry or chemical engineering toward the Doctor of Philosophy degree must include in their program Chemistry 342, 343, 344, and 345, or must receive from the physical chemistry division of the department a written statement that similar courses taken at other institutions are the equivalent.

Students majoring in other departments who desire a first minor in chemistry or chemical engineering toward the Doctor of Philosophy degree must include in their program Chemistry 342 and 343 or the equivalent.

Candidates for the degree of Master of Science in the Teaching of Chemistry must earn four units in chemistry, two units in education, and two units in electives. The two units in education must include Education 311 and 312 and two of the following courses: Education 301, 302, 303, 304. The electives may be in chemistry, in education, or, in exceptional cases, in other fields. For admission to this program, the student must have a 3.5 average. Students are not admitted on limited status. The adviser for candidates for this degree is Professor J. C. Bailar, Jr., 107 Chemistry Annex.

For work in physical sciences, see page 233.

FELLOWSHIPS AND ASSISTANTSHIPS

The Graduate College offers fellowships to worthy students, including those who intend to specialize in chemistry or chemical engineering. In addition, the Department of Chemistry and Chemical Engineering has a number of fellowships sponsored by industrial concerns and by other organizations. Application for fellowships should be made to the Dean of the Graduate College.

Teaching assistantships in chemistry and chemical engineering are numerous. These are open to all graduate students or students who are entering for graduate study. Research assistantships for chemistry and chemical engineering students are available; these are usually awarded to students who have already been in residence at the University of Illinois and who have demonstrated their ability to do graduate work. Application for assistantships should be made directly to the Department of Chemistry and Chemical Engineering, 106 Noyes Laboratory.

The department usually has postdoctoral research appointments available. Application for these should be made to the staff members supervising the research. In addition, the Graduate College offers several postdoctoral University fellowships.

GRADUATE TEACHING FACULTY

Professors: H. E. Carter (Head of Department), R. Adams, L. F. Audrieth, J. C. Bailar, Jr., G. L. Clark, D. Y. Curtin, H. G. Drickamer, D. T. Englis, R. C. Fuson, I. C. Gunsalus, H. F. Johnstone, H. A. Laitinen, N. J. Leonard, C. S. Marvel, T. Moeller, T. E. Phipps, H. R. Snyder, S. Swann, Jr., C. S. Vestling, F. T. Wall.

Associate Professors: Virginia Bartow, H. S. Gutowsky, R. F. Nystrom, B. R. Ray, J. W. Westwater, P. E. Yankwich.

Assistant Professors: E. J. Corey, J. C. Garver, T. J. Hanratty, L. M. Henderson, R. H. Herber, L. A. Hiller, Jr., J. Larner, H. V. Malmstadt, M. S. Peters, R. J. Rubin, W. J. Rutter.

Instructors: D. E. Applequist, R. L. Belford, A. M. Hartley, R. S. Juvet, M. Karplus, A. Kuppermann, K. L. Rinehart.

COURSES FOR GRADUATES

402. **Inorganic Chemistry.** The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. I or II; ¾ unit. Moeller.

404. **Advanced Inorganic Chemistry Laboratory.** Specialized laboratory techniques; more difficult inorganic syntheses. II; ¼ to ¾ unit. Prerequisite:

Credit or registration in one of the lecture courses in inorganic chemistry in the 400 series. AUDRIETH, MOELLER.

405. **Inorganic Chemistry.** Seminar. Required of all graduate students whose major is inorganic chemistry. I, II; ¼ unit. AUDRIETH, BAILAR.

406. **Special Topics in Inorganic Chemistry.** Discussions and reports. I, II; ¾ unit. AUDRIETH, BAILAR.

407. **Nonaqueous Solvents and the Chemistry of Hydronitrogens.** Liquid ammonia and nonaqueous systems; nonaqueous solvents as media for chemical reactions; the hydronitrogens and their derivatives. I or II; ¾ unit. Prerequisite: Chemistry 315. AUDRIETH.

408. **The Chemistry of Complex Inorganic Compounds.** The nature of the coordinate bond; applications of complex compounds. I or II; ¾ unit. Prerequisite: Chemistry 315. BAILAR.

420. **Electronic Instruments in Chemical Analysis.** Discussion of the principles and characteristics of electronic circuits and instruments used for analysis and research in chemistry. Laboratory experimentation and familiarization with basic instrumental components and specific chemical instruments. II; ½ unit. Prerequisite: Chemistry 327, or Chemistry 421 and 422, or consent of instructor. MALMSTADT.

421. **Spectrochemical Methods of Analysis.** Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. I; 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree. MALMSTADT.

422. **Electrical Methods of Chemical Analysis.** Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. II; 1 unit. Prerequisite: Chemistry 344 or equivalent. LAITINEN.

424. **Quantitative Analysis.** Advanced principles, including chemical statistics, calculations, experimental methods, and applications. II; ½ unit.

425. **Analytical Chemistry.** Seminar. Special topics in analytical chemistry. Required of all graduate students whose major is analytical chemistry. I, II; ¼ unit. CLARK.

426. **Applied X-rays.** Lectures. I; ¾ unit. Prerequisite: Training in physics and physical chemistry. CLARK.

427. **Applied X-rays: Crystallography.** Lectures. II; ¾ unit. Prerequisite: Training in physics and physical chemistry. CLARK.

428. **Applied X-rays.** Laboratory. Training in operation of all types of X-ray apparatus with special emphasis on diffraction; experimental chemical identification and crystal structure analyses from powder and single crystal patterns. I, II; ¼ to 1 unit. Prerequisite: Chemistry 426 or 427; training in physics, mathematics, and physical chemistry. CLARK.

429. **Electron Microscopy.** Lectures, discussions, and demonstrations on electron optics, design and operation of electron microscopes; sectioning, replication, and shadow casting of specimens; applications in various sciences. Laboratory work, concurrent with lectures, is optional. I; ¼ or ½ unit. CLARK.

430. **Organic Chemistry.** Survey of organic chemistry designed for first-year graduate students. I, II; 1 unit. Prerequisite: One year (ten hours) of organic chemistry. FUSON, SNYDER.

432. **Organic Chemistry.** Advanced survey of organic chemistry. To follow Chemistry 430. II; 1 unit. Prerequisite: Chemistry 430 or equivalent. LEONARD.

433. **Organic Chemistry.** Molecular structure and reaction mechanisms with

emphasis on stereochemistry. I; ¾ unit. Prerequisite: Chemistry 430 and 432, or consent of instructor. COREY, CURTIN.

434. **Advanced Organic Synthesis.** I, II; ½ to 1 unit. APPLEQUIST, RINEHART.

435. **Organic Chemistry.** Seminar. Current literature in organic chemistry. I, II; ½ unit. Prerequisite: Consent of instructor. In most cases, students must be doing research in organic chemistry and be registered for the degree of Doctor of Philosophy. ORGANIC STAFF.

436. **Organic Chemistry.** Quantitative organic analysis and newer methods in organic laboratory procedure. A laboratory course designed to acquaint students with newer research techniques. I, II; ½ to 1 unit. COREY.

440. **Physical Chemistry.** Survey of physical chemistry for graduate students. I, II; 1 unit. Prerequisite: Consent of instructor. PHIPPS.

441. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and calculation of thermodynamic quantities. I; 1 unit. Prerequisite: One year of physical chemistry. GUTOWSKY.

442. **Chemical Thermodynamics.** Continuation of Chemistry 441. II; 1 unit. Prerequisite: Chemistry 441 or consent of instructor. GUTOWSKY.

444. **Kinetic Theory.** Selected topics dealing with the classical kinetic theory of gases. Study of theoretical and certain experimental aspects of atomic and molecular beams. I or II; ¾ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Chemistry 441 and 442. PHIPPS.

445. **Physical Chemistry.** Seminar. Required of all graduate students whose major is physical chemistry. I, II; ¼ to ½ unit. Prerequisite: Consent of instructor. GUTOWSKY.

446. **Quantum Chemistry, I.** An introduction to quantum mechanics: basic theory and methods of approximations; applications to atomic systems. I; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Chemistry 349 and Mathematics 388, or equivalent; consent of instructor. KARPLUS.

447. **Quantum Chemistry, II.** Continuation of Chemistry 446. Application of quantum mechanics to chemical problems; theories of the chemical bond; structure and spectra of molecules. II; 1 unit. Prerequisite: Chemistry 446 or equivalent; consent of instructor. KARPLUS.

448. **Chemical Kinetics.** Chemical reaction and the theory of rate processes. Lectures. II; ¾ unit. Offered in 1956-1957 and in alternate years. Prerequisite: One year of physical chemistry; consent of instructor. YANKWICH.

449. **Special Topics in Physical Chemistry.** An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as molecular spectroscopy, statistical mechanics, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. Students may register for credit more than once. I, II; ½ to 1 unit. Prerequisite: Consent of instructor.

450. **Chemistry of Metabolic Processes.** A consideration at the chemical level of biological processes, including energy coupled reactions, biosynthesis, and the degradation of cellular components. Lectures and readings. I; ¾ unit. Prerequisite: Chemistry 350 and 355, or equivalent. GUNSALUS, VESTLING.

452. **Experimental Techniques in Biochemistry.** Experiments on the isolation, purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. I, II; ½ to 1 unit. Prerequisite: Chemistry 350 and 355. HENDERSON.

455. **Biochemistry.** Seminar. Discussions of current research and literature. Required of all graduate students whose major is biochemistry. I, II; ½ unit. Prerequisite: Chemistry 350 and 355, or equivalent. GUNSALUS.

490. **Research.** Candidates for the Master of Arts or Master of Science degree who elect research are required to present a thesis. A thesis is always required of students working toward the degree of Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Students whose major is in departments other than chemistry must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. I, II; ¼ to 4 units. Work may be taken in the following fields, subject to the approval of one of the qualified staff members:

Analytical Chemistry (including X-rays, Electron Microscopy, Polarography, Food and Plant Chemistry). CLARK, ENGLIS, LAITINEN, MALMSTADT.

Biochemistry. CARTER, GUNSALUS, HENDERSON, LARNER, RUTTER, VESTLING.

Inorganic Chemistry. AUDRIETH, BAILAR, HERBER, HILLER, MOELLER.

Organic Chemistry. ADAMS, COREY, CURTIN, FUSON, LEONARD, MARVEL, SNYDER.

Physical Chemistry (including Radiochemistry). GUTOWSKY, PHIPPS, RAY, RUBIN, WALL, YANKWICH.

Chemistry:

Applied Electrochemistry (Organic and Inorganic). SWANN.

Radiocarbon Chemistry. NYSTROM.

Students who intend to major in chemistry in one of these special fields should consult with the professor in charge of the thesis and with the head of the Department of Chemistry and Chemical Engineering in regard to the program of courses and examinations.

492. **Chemical Literature and Reference Work.** I; ¼ unit. BARTOW.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Animal Nutrition 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. I; 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Inorganic Chemistry.** Nuclear and extranuclear atomic structures and their relation to the properties of the elements and of their compounds; types of bonding; survey of the periodic relationships, preparation, and applications of the elements and their compounds. I, II; ¾ unit. Prerequisite: Fifteen hours of credit in chemistry courses exclusive of courses numbered below 110. AUDRIETH.

316. **Inorganic Chemistry.** Preparation of typical inorganic compounds illustrating special and more advanced techniques. I, II; ½ unit. Prerequisite: Credit or registration in Chemistry 315. AUDRIETH, MOELLER.

324. **Introductory Microanalysis and Microscopy.** Qualitative spot tests, crystal tests, microscopic techniques; quantitative microvolumetric and gravimetric methods. Lectures and laboratory. I; ¾ unit. Prerequisite: Chemistry 124 or equivalent.

325. **Analytical Chemistry.** A survey course for advanced undergraduate and graduate students requiring further training and review in analytical chemistry. I; ¾ unit. Prerequisite: Advanced standing in chemistry. LAITINEN.

326. **Chemical Analysis and Treatment of Water.** Chemical and instrumental methods for analysis of water and determination of quality; chemical prin-

ciples and processes in water purification and conditioning; relationship of chemistry of water to municipal and industrial use. I; ¾ unit. Prerequisite: Chemistry 124. ENGLIS.

327. **Special and Instrumental Methods of Analysis.** Electrical and optical methods, and other advanced analyses. I, II; ¾ unit. Prerequisite: Chemistry 124, 234, 342, and 343; or consent of instructor. MALMSTADT.

328. **Organic Functional Group Analysis.** A study of the quantitative separation and determination of organic compounds via functional groups: instrumental, manometric, gravimetric, and volumetric methods. II; ¾ unit. Prerequisite: Chemistry 124 and 336 or equivalent. JUVET.

329. **Food Analysis.** Quantitative organic analysis of food products; alcohols, carbohydrates, fats and oils, cereals, nitrogenous bodies, preservatives, and colors. II; 1¼ units. Prerequisite: Chemistry 122 or 124, and 133 or 234. ENGLIS.

333. **Applied Electrochemistry.** Use of electric current through solutions for carrying out reactions. Lectures. Open to students in the curriculum in chemistry and chemical engineering. II; ½ unit. Prerequisite: Chemistry 234, 336, and 344. SWANN.

336. **Organic Chemistry.** Second course. Lectures and recitations. I, II; ¾ unit. Prerequisite: Chemistry 124 and 234. CURTIN, MARVEL.

337. **Organic Chemistry.** Laboratory experiments in organic chemistry. I, II; ½ unit. Prerequisite: Chemistry 234; credit or registration in Chemistry 336. APPLEQUIST.

338. **Systematic Identification of Organic Compounds.** I, II; ¾ unit. Prerequisite: Chemistry 336 and 337, or equivalent. FUSON, SNYDER.

339. **Theoretical Organic Chemistry.** Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free radicals, and carbanions. II; ¾ unit. Prerequisite: Chemistry 338 or consent of instructor.

340. **Elementary Physical Chemistry.** A one-semester course in chemical principles with emphasis on topics and applications most important to students in agriculture, the biological sciences, and pre-medicine, and to graduate students needing a brief foundation course. Not open to students in the specialized curricula in chemistry or chemical engineering. I; ¾ unit. Prerequisite: Physics 102 or 104, Chemistry 122 and 133, or equivalent; registration in Chemistry 341.

341. **Elementary Physical Chemistry Laboratory.** To accompany Chemistry 340. Quantitative experiments chosen to emphasize basic principles and also to acquaint the students with important laboratory techniques. I; ¼ unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry.

342. **Physical Chemistry.** This course and Chemistry 344 constitute a one-year study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. I, II; ¾ unit. Prerequisite: Chemistry 124; Physics 106, 107, and 108, or two semesters of general physics with registration in the third semester; credit or registration in Mathematics 142 (preferred) or 147; or equivalents. BELFORD, RUBIN, YANKWICH.

343. **Physical Chemistry Laboratory.** Quantitative experimental study of chemical principles. Chemistry 343 and 345 constitute a one-year introduction to

experimental physical chemistry. They may be taken consecutively or concurrently. I, II; ¼ unit. Prerequisite: Chemistry 342. BELFORD.

344. **Physical Chemistry.** Continuation of Chemistry 342. I, II; ¾ unit. Prerequisite: Chemistry 342. BELFORD, RUBIN, YANKWICH.

345. **Physical Chemistry Laboratory.** Continuation of Chemistry 343. May be taken concurrently with Chemistry 343. I, II; ¼ unit. Prerequisite: Chemistry 342; credit or registration in Chemistry 343 and 344. BELFORD.

346. **Colloid and Surface Chemistry.** Physical chemistry of colloid systems; properties of surfaces and interfaces; applications. I; ¾ unit. Prerequisite: Chemistry 344 or consent of instructor. RAY.

347. **Colloid and Surface Chemistry Laboratory.** To accompany Chemistry 249 or 346. Individual experiments in colloid and surface chemistry. I, II; ¼ unit. Prerequisite: Credit or registration in Chemistry 249 or 346, or consent of instructor. RAY.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. Graduate students registering for one unit do a special project. I; ¾ to 1 unit. Prerequisite: Chemistry 344 or equivalent. KARPLUS.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. Graduate students registering for one unit do a special project. II; ¾ to 1 unit. Prerequisite: Chemistry 348. KARPLUS.

350. **General Biochemistry.** The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings. I, II; ¾ unit. Prerequisite: Chemistry 122 or 124, and 133 or 234, or equivalent; registration in Chemistry 354 or 355. CARTER.

351. **Metabolic Processes, Problems and Methods.** Laboratory experiments stress methods of conducting metabolic experiments with tissues, cells, cell components, and enzymes. Weekly discussions consider present concepts of the mechanism of chemical transport, hormone control, energy release, and of biosynthesis. II; ¾ unit. Prerequisite: Chemistry 350 and 355. LARNER.

352. **Biochemistry of Vitamins and Hormones.** Transformation of micronutrients including their biosynthesis, functional forms, and sites of action; chemistry and functional role of hormones and other regulatory compounds. II; ¾ unit. Prerequisite: Chemistry 350 and 355, or equivalent. HENDERSON.

354. **Biochemistry Laboratory.** Chemical experiments with compounds and reactions of living systems, particularly carbohydrates, lipids, proteins, nucleic acids and the alimentary processes, blood, tissues, and metabolism. For students who wish a working knowledge of experimental biochemistry with emphasis on mammalian functions and processes, and do not intend to undertake further courses in biochemistry. Does not serve as prerequisite for advanced courses. I; ½ unit. Prerequisite: Chemistry 122 or 124, and 133 or 234, or equivalent; registration in Chemistry 350. VESTLING.

355. **Biochemistry Laboratory.** To accompany Chemistry 350. Required of all students who expect to take advanced courses in biochemistry. An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance; identification and quantitative measurement of constituents and transformations in biological systems. Laboratory,

quizzes, and assigned readings. I, II; ¾ unit. Prerequisite: Chemistry 122 or 124, and 133 or 234, or equivalent; registration in Chemistry 350. RUTTER, LARNER.

358. **Chemistry of Biological Catalysis.** Formation, properties, structure, and mechanism of action of enzymes and other biocatalysts. Lectures and readings. II; ¾ unit. Prerequisite: Chemistry 350 and 355, or equivalent. RUTTER.

391. **Special Problems in Chemistry.** Designed to strengthen the chemical background of high school teachers. Reading, reports, discussions, and problems selected to meet the needs of each individual enrolled in the course. I, II; ¼ to ¾ unit. Prerequisite: Registration in some other advanced course in chemistry; experience in high school teaching.

394. **Principles of Chemical Thermodynamics.** Thermodynamics and free energy calculations. I, II; ¾ unit. Prerequisite: Chemistry 342 and 344 or consent of instructor. PHIPPS.

395. **History of Science with Particular Reference to Chemistry.** I; ¼ unit. Prerequisite: Twenty hours of laboratory science. BARTOW.

396. **Atomic Physics.** Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics include the atomic nature of matter, the properties of free electrons, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, an introduction to the ideas of quantum mechanics, binding in molecules and crystals, and an introduction to some solid state phenomena. It is recommended that chemistry majors take Chemistry 344 before registering in this course. I, II; 1 unit. Prerequisite: General physics and Mathematics 343 or 345, or consent of instructor.

397. **Radiochemistry.** Properties of radioactive nuclei, nature of radioactivity, nuclear reactions, detection equipment, and tracer technique. Lectures. I, II; ½ unit. Prerequisite: Chemistry 342 and 343.

398. **Radiochemistry.** Laboratory to accompany Chemistry 397. I, II; ¼ unit. Prerequisite: Chemistry 342 and 343; credit or registration in Chemistry 397; consent of instructor.

Chemical Engineering

The Department of Chemistry and Chemical Engineering offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Chemical Engineering. Candidates for these degrees should have had undergraduate training comparable to that offered at the University of Illinois, including mathematics through calculus, and one-year courses in physics, mechanics, and electrical engineering. Students who enter without the usual engineering courses prescribed in the undergraduate chemical engineering curriculum are required to make up their deficiencies to the extent prescribed by their adviser.

Candidates for an advanced degree in chemical engineering must have had the equivalent of twenty-five hours in chemistry, including organic and physical chemistry.

A reading knowledge of German and French or Russian is recommended for all graduate students in chemical engineering. It is not required of students who are candidates for the master's degree. In meeting the language requirements for the degree of Doctor of Philosophy in Chemical Engineering, a student may substitute Russian for French on the direct recommendation of the Department of Chemistry and Chemical Engineering (and without formal petition), provided that such recommendation is approved by the Dean of the Graduate College.

Candidates for the Master of Science degree in Chemical Engineering must include Chemical Engineering 487 and 488 among their courses.

A student who chooses chemical engineering as a minor must take at least two units of work in this subject for the Master of Science degree or four units for the Doctor of Philosophy degree.

COURSES FOR GRADUATES

464. **Diffusional Operations.** The principles of diffusion and their application to the unit operations of absorption, extraction, evaporation, drying, humidification, and dehumidification. Lectures. II; 1 unit. Prerequisite: Chemical Engineering 373. JOHNSTONE.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. I, II; ¼ unit. Prerequisite: Chemical Engineering 373. DRICKAMER, JOHNSTONE.

466. **Filtration and Separations.** Properties of particulate matter: aerosols, suspensions, slurries, and packed beds; methods of comminution and separation. Lectures and problems. I; ¾ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Chemical Engineering 373. JOHNSTONE.

467. **Distillation.** Application of principles of distillation to binary and multicomponent mixtures including a discussion of azeotropic and extractive distillation. II; ¾ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Chemical Engineering 373. DRICKAMER.

468. **Advanced Plant Design.** Problems in equipment design and plant layout. Lectures and conferences. I; ¾ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Chemical Engineering 373, 487, and 488. JOHNSTONE.

469. **Industrial Reaction Kinetics and Catalysis.** Prediction of physical properties and absolute reaction rates; application to design of industrial reactors. II; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Consent of instructor. DRICKAMER.

487. **Flow of Fluids.** Advanced course. Lectures, recitations, and problems. I; ¾ unit. Prerequisite: Chemical Engineering 371, or equivalent with consent of instructor. HANRATTY.

488. **Heat Transmission.** Advanced course. Lectures, recitations, and problems. I; ¾ unit. Prerequisite: Chemical Engineering 371, or equivalent with consent of instructor. WESTWATER.

490. **Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the degree of Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another department must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. I, II; ¼ to 4 units. DRICKAMER, HANRATTY, JOHNSTONE, PETERS, SWANN, WESTWATER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Process Engineering.** Same as Food Technology 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food technology; not open to majors in chemical engineering. Lectures and problems. I; ¾ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Chemistry 340 or 342; one year of calculus. GARVER.

370. **Chemical Engineering Thermodynamics.** The fundamental concepts and laws of thermodynamics. Primarily for students in chemical engineering. II; ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 342. PETERS.

371. **Principles of Chemical Engineering.** Scientific principles in unit operations of chemical engineering. Lectures, problems, and quizzes. I, II; 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor. HANRATTY, PETERS.

373. **Principles of Chemical Engineering.** Scientific principles in unit operations of chemical engineering. Lectures, problems, and quizzes. I, II; 1 unit. Prerequisite: Chemical Engineering 371. DRICKAMER, WESTWATER.

374. **Unit Operations Laboratory.** To accompany Chemical Engineering 373. Laboratory and computations in the unit operations. I, II; ½ unit. Prerequisite: Credit or registration in Chemical Engineering 373. GARVER, HANRATTY.

377. **Chemical Engineering Technology.** Study of industrial chemical processes and principles. II; ½ unit. Prerequisite: Chemical Engineering 261. WESTWATER.

379. **Chemical Engineering Projects.** Laboratory. Development of an individual project. I, II; ½ unit. DRICKAMER, JOHNSTONE, WESTWATER.

380. **Chemical Engineering Calculations.** Numerical and graphical methods for problems in equilibria and kinetics. Lectures and recitations. II; ¾ unit. Prerequisite: Chemistry 394; Chemical Engineering 371. HANRATTY.

381. **Chemical Engineering Plant Design.** Comprehensive problems. I, II; ½ unit. Prerequisite: Chemical Engineering 373. PETERS.

382. **High Pressure Reactions.** Lectures, recitations, and problems. I; ½ unit. Prerequisite: Consent of instructor. DRICKAMER.

385. **Bioengineering.** Study of special processes and unit operations used in the production of foodstuffs, pharmaceuticals, and fine chemicals. Lectures and problems. I; ¾ unit. Prerequisite: Credit or registration in Chemical Engineering 373 or consent of instructor. GARVER.

386. **Fermentation Engineering.** Principles of chemical engineering applied to the fermentation and allied industries. Lectures and problems. II; ¾ unit. Prerequisite: Bacteriology 300 and Chemistry 234 and 342, or consent of instructor. GARVER.

CITY PLANNING AND LANDSCAPE ARCHITECTURE

The Department of City Planning and Landscape Architecture offers graduate work leading to the Master of Fine Arts and Master of Science degrees. Students applying for admission must have a grade-point average of at least 3.5 for that portion of the work which represents the last 50 per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training. Students on limited status are admitted.

Degree of Master of Science in City Planning. College graduates in architecture, city planning, civil engineering, landscape architecture, and the social sciences are offered an opportunity to prepare themselves for careers in city, state, and regional planning. After completing their preparation they are qualified for positions with city, metropolitan, state, and regional planning commissions and with planners in independent practice.

The prerequisite for graduate work in city planning is a bachelor's degree in architecture, city planning, civil engineering, landscape architecture, or the social sciences, and must include courses of the following character or their

equivalents: city planning (introductory), three hours; sociology (urban, rural, or regional), three hours; political science (municipal government and problems; public administration), three hours; economics (theory and practice of modern economic society; urban land economics; public finance), three hours; design (skill in graphic expression and techniques of special design; landscape or architectural design or highway and municipal design; regional design), twelve hours.

To qualify for this degree a student must take the seminar and thesis courses for three units and at least five additional units chosen from the following fields: architecture, civil engineering, economics, geography, political science, sociology. With proper authorization the student may make selection from these or other graduate courses having a close relationship to the city planning field.

Degree of Master of Fine Arts in Landscape Architecture. The prerequisite for graduate work in landscape architecture is a bachelor's degree in landscape architecture substantially equivalent to the degree conferred by the University of Illinois.

To qualify for this degree a student must take the seminar and thesis courses for three units and at least five additional units chosen from the following: architecture (advanced undergraduate courses in design or history), one unit; botany (graduate or advanced undergraduate courses), one unit; Civil Engineering 323, one unit; Landscape Architecture 436, one to two units; Landscape Architecture 447, one to two units; Landscape Architecture 457, one to two units.

FELLOWSHIPS

The St. Louis (Missouri) Metropolitan Planning Fellowship, with a stipend of $900, is offered by the St. Louis Regional Planning and Construction Foundation to a qualified student who is a resident of the St. Louis area (within a radius of one hundred miles of St. Louis) and who plans to enroll in the Graduate College to work for a master's degree in city planning. Requests for information and information blanks should be addressed to the Graduate College.

GRADUATE TEACHING FACULTY

Professors: L. B. Wetmore (Head of Department), H. Bartholomew, W. M. Keith, S. H. White, J. Wood.

City Planning

COURSES FOR GRADUATES

437. **Advanced City Planning Design.** Analysis and synthesis of problems and possibilities in the layout of average towns and cities and their surroundings. I, II; 1 to 2 units. Prerequisite: Enrollment for master's degree in city planning.

487. **Seminar.** I, II; ½ unit.

488. **City Planning Research.** Individual and group instruction in application of professional training in city planning and other fields to the analysis of urban planning problems and to the development of approaches to solution of these problems. I, II; ½ to 2 units. Prerequisite: Consent of instructor.

491. **Thesis.** I, II; ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **City Planning Design.** I; 1 unit. Prerequisite: Landscape Architecture 236 or consent of instructor.

338. **City Planning Design.** II; 1 unit. Prerequisite: City Planning 337 or consent of instructor.

372. **Theory and Practice.** The unified development of communities; comprehensive arrangement of land uses and land occupancy. I, II; ½ unit.

376. **Planning Procedures, Methodologies, and Practice.** Procedures involved in major types of planning services, special planning studies, planning techniques and methodologies, organization and administration of planning staffs and agencies, professional practice. I; ½ unit. Prerequisite: Consent of instructor.

Landscape Architecture

COURSES FOR GRADUATES

436. **Advanced Landscape Design.** Landscape design of large private, semi-public, and public properties. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

447. **Advanced Landscape Construction.** Construction problems connected with large private and public landscape developments. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

457. **Advanced Planting Design.** Theory and application of planting design in relation to private, semi-public, and public properties. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture. WHITE.

487. **Seminar.** I, II; ½ unit.

491. **Thesis.** I, II; ½ to 2 units. STAFF.

CIVIL ENGINEERING

(Including Sanitary Engineering)

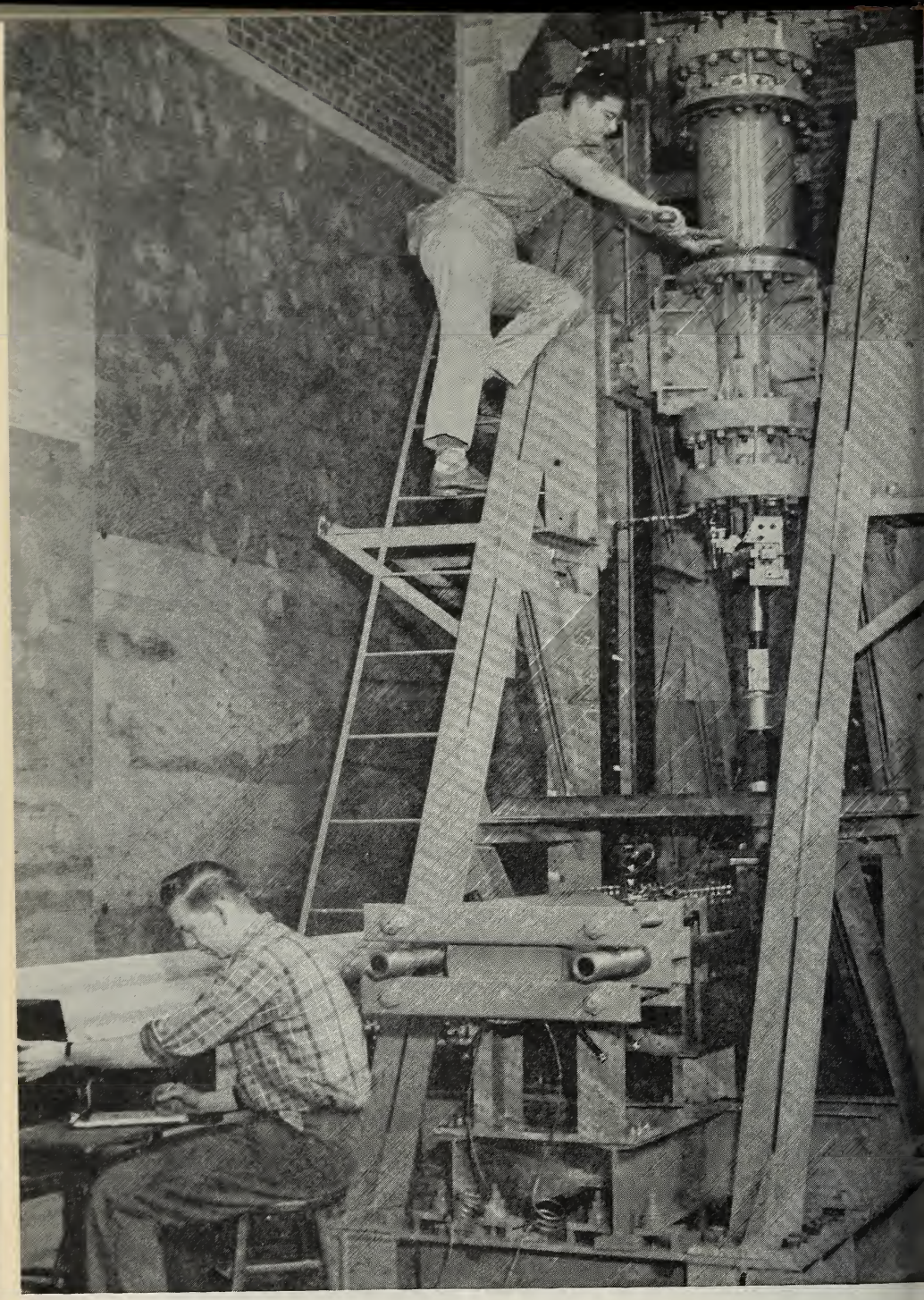
The graduate student in civil engineering generally follows one of three fields: transportation and municipal engineering, hydraulic engineering, or structural engineering, including soil mechanics and foundations. The work leads to the degree of Master of Science in Civil Engineering and to the degree of Doctor of Philosophy in Engineering. A prerequisite for graduate work in civil engineering is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired.

The work in sanitary engineering leads to the degree of Master of Science in Sanitary Engineering and to the degree of Doctor of Philosophy in Engineering. The prerequisite for admission to the first year of graduate study is a degree of Bachelor of Science in Sanitary Engineering or the satisfactory completion of the sanitary option in a course in civil engineering, including basic courses in bacteriology, quantitative chemical analysis, and organic chemistry, or their equivalent in the fields of chemistry and biology.

In order to be admitted to graduate work in civil engineering or sanitary engineering, a student must have an undergraduate grade-point average of at least 3.75 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or a minor are subject to the review of and must be approved by the head of the department.

A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units of formal course work are required.



A special testing machine developed to study the behavior of structural materials under dynamic loads.

A pamphlet describing the opportunities for graduate work and research in the Department of Civil Engineering is available upon request to the head of the department.

For information concerning applied mathematics, see page 28.

ASSISTANTSHIPS

A number of part-time research assistantships are available in the department. Appointments are for a term of one or two years. Assistants receive a stipend and are exempt from the payment of tuition fees. The stipend is $1,500 for the academic year for approximately one-half time devoted to research duties in the Engineering Experiment Station, the remainder to graduate study.

Appointments to research assistantships are made only to students with outstanding records or other excellent qualifications. Appointments are given to both first-year and second-year graduate students, but only rarely to third-year students who have not previously studied at Illinois. In general, a half-time assistant requires two academic years of residence to obtain the master's degree.

Application blanks for research assistantships are available upon request to the head of the department, 201 Civil Engineering Hall. Applications must be made before March 15 of each year for awards for the year beginning in September.

GRADUATE TEACHING FACULTY

Professors: N. M. Newmark (Head of Department), E. E. Bauer, E. J. Daily, E. Danner, G. H. Dell, J. C. Dietz, J. J. Doland, W. H. Munse, W. A. Oliver, R. B. Peck, M. O. Schmidt, T. C. Shedd, C. P. Siess, T. H. Thornburn, J. Vawter.

Associate Professors: W. J. Austin, J. W. Briscoe, V. T. Chow, D. U. Deere, J. C. Guillou, W. W. Hay.

Assistant Professors: J. E. Baerwald, T. Y. Chen, W. J. Hall, H. O. Ireland, N. Khachaturian, J. M. Massard, R. J. Mosborg, J. E. Stallmeyer, A. S. Veletsos.

Lecturer: K. Terzaghi.

COURSES FOR GRADUATES

401. Geodetic Engineering. Elements of geodesy; principles and practice of precise triangulation, traverse, and levels. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. Schmidt.

402. Geodetic Engineering. Astronomic determination of latitude, longitude, and azimuth; systems of plane coordinates; map projections; electronic and special control surveys. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. Schmidt.

420. Highway Pavement Design, I. Analysis and methods of measurement of road surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper road surface properties, load carrying capacity, wear resistance, stability and durability. I; 1 unit. Prerequisite: Civil Engineering 220 or equivalent. E. Danner.

421. Highway Pavement Design, II. Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. II; 1 unit. Prerequisite: Civil Engineering 420 or consent of instructor. E. Danner.

422. **Municipal Administration and Engineering.** Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and zoning, building codes and inspection; street lighting; public utilities; city cleaning; recreational development. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. E. DANNER.

423. **Traffic Planning.** Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. II; 1 unit. Prerequisite: Civil Engineering 323 or equivalent. BAERWALD.

425. **Railroad Location and Operation.** Track and traffic capacity, optimum size of train, train performance diagram, train scheduling and make-up improvement of existing lines, examples of modern location. I; 1 unit. Prerequisite: Civil Engineering 203, 226, or equivalent experience, or consent of instructor. HAY.

426. **Railroad Location and Operation.** Roadbeds under load, roadbed stabilization, design of ballast section, ties, rails, and fastenings, economics of grade separation, recent examples of roadway and track problems. II; 1 unit. Prerequisite: Civil Engineering 425, or equivalent, or consent of instructor. HAY.

440. **Water Supply.** Water resources and use; design, construction, and operation of water distribution systems. I; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent. DIETZ.

443. **Sewerage.** Design, construction, maintenance, operation, and financing of sewer systems. II; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent. DIETZ.

444. **Sewage Disposal, Wastes Disposal, and General Sanitation.** Fundamental principles and practical considerations associated with sewage and industrial waste disposal, including the design, operation, and control of the various treatment units. II; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent. DIETZ, ENGELBRECHT.

446. **Water Purification and General Sanitation.** Fundamental principles and practical considerations associated with water treatment, including the design, operation, and control of the various unit processes. I; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent. DIETZ.

448. **Sanitary Engineering Laboratory.** Laboratory evaluation of the various unit processes practiced in water, sewage, and industrial waste treatment; their application, significance, and control. I, II; 1 to 2 units. DIETZ, ENGELBRECHT.

450. **Hydrology and Flood Control.** Magnitude and frequency of flood flow of streams, minimum flow of streams and regulation of flow by storage reservoirs; intense rainfall and the development of intensity curves for use in rational run-off formula; unit-graph method of computing flood run-off; flood control and prevention by channel improvement, levees, and reservoirs. I; 1 unit. Prerequisite: Civil Engineering 250 and 351, or equivalent. DOLAND.

452. **Water Resources Planning and Development.** Purposes and techniques of planning water resources developments; methods of evaluating the engineering and economic aspects of water conservation projects developed through the examination of actual proposals. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. DOLAND.

455. **Water Power Engineering.** Preliminary investigations of site, available water supply, machinery selection, design of water passages, arrangement and space allocation in power houses, load curve studies, hydrosteam association, and speed and pressure regulation. II; 1 unit. Prerequisite: Civil Engineering 250 or 450. DOLAND.

457. **Hydraulic Engineering Laboratory.** Design, construction, and testing of individual or semi-individual laboratory studies. Study and discussion of advanced subjects of hydraulic engineering phenomena. I; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. DOLAND.

458. **Open Channel Flow.** Classification of types of flow, channel roughness, backwater curve computations, hydraulic jump analysis, special transitions, canal design, study of supercritical velocity flow, unsteady flow and flood movements; modern developments in open channel flow theory and design practice. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. CHOW.

460. **Structural Analysis.** Basic theory of indeterminate structures; deflections and displacements; continuous beams and frames; virtual work; qualitative and quantitative influence lines. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with a course in theory of simple structures. OLIVER, VAWTER.

461. **Structural Theory and Design.** General theory of continuity; moment distribution; the column analogy; rigid frame bridges and buildings; fixed and continuous arches; classification of structures from viewpoint of design. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering with a basic course in indeterminate structures. SHEDD, VAWTER.

462. **Structural Theory and Design.** Statically indeterminate trusses; continuous trusses, steel arches; secondary stresses; suspension bridges; long-span roofs; skeleton steel buildings. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering with a fundamental course in indeterminate structures. SHEDD, VAWTER.

463. **Analysis and Design of Prestressed Concrete Structures.** The principles of linear prestressing; study of materials used in prestressed concrete; methods of linear prestressing; design of simple beams on the basis of working stresses and on the basis of the ultimate load; statically indeterminate prestressed concrete structures; design of continuous prestressed concrete beams. I, II; 1 unit. Prerequisite: Bachelor of Science degree in civil or architectural engineering with courses in structures and reinforced concrete design. KHACHATURIAN.

464. **Reinforced Concrete Design.** Theories of action of beams, slabs, and columns of reinforced concrete; codes and specifications and their influence on design; effect of continuity. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with courses in structures. DAILY, SHEDD.

465. **Steel Design.** Design of steel members; codes and specifications for buildings; riveted and welded connections; evolution of bridge specifications; loads and working stresses; economic proportions. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with courses in structures. SHEDD.

466. **Behavior of Reinforced Concrete Members.** Studies of the actual behavior and strength of reinforced concrete members by means of critical reviews of the more significant experimental and analytical investigations. Emphasis is placed on the empirical nature of current design specifications and their relation to the results of research. Beams subjected to pure flexure, columns subjected to axial compression, combined flexure and axial compression,

combined flexure and shear, and bond. I; 1 unit. Prerequisite: Bachelor of Science degree in civil or architectural engineering with courses in structures and reinforced concrete design. SIESS.

467. **Behavior of Reinforced Concrete Structures.** Continuation of Civil Engineering 466. Studies of behavior and strength of statically indeterminate reinforced concrete structures and structural elements: frames, floor slabs in buildings, isolated column footings. II; 1 unit. Prerequisite: Civil Engineering 466 or consent of instructor. SIESS.

469. **Wood Structures.** Theory and practice in the design of modern wood structures; the effect of the plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. I, II; 1 unit. OLIVER.

470. **Earth Pressures and Retaining Walls.** A study of earth pressures considering the significant properties of soils; methods of computing earth pressures and the limitations in their dependability; stability computations; and the design and construction of retaining walls and abutments. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering.

471. **Earth and Masonry Dams.** Stability of rolled-fill and hydraulic-fill earth dams and rock-filled dams; methods of construction; seepage losses; control of seepage forces; safety of foundations; solid gravity, arched gravity, arch, multiple arch and slab and buttress dams; safety against sliding and overturning; unit stresses on horizontal sections and principal stresses; joints; drainage; foundations. II; ½ to 1 unit. PECK.

473. **Soil Mechanics.** Advanced studies of research techniques in soil mechanics and foundation engineering. I; 1 unit. Prerequisite: Civil Engineering 374 or consent of instructor. PECK.

474. **Foundation Engineering.** Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. II; 1 unit. Prerequisite: Credit or registration in Civil Engineering 374 or consent of instructor. DEERE, PECK.

475. **Soil Engineering for Transportation Facilities.** Problems of soil classification; factors affecting the stability of subgrades, slopes, and embankments. I; 1 unit. Prerequisite: Civil Engineering 373 or equivalent.

481. **Numerical and Approximate Methods of Structural Analysis.** Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns and frameworks, moments and deflections of beams resting on elastic or plastic supports, vibrations and transient loading of beams and of complex structural assemblies. I or II; 1 to 2 units. AUSTIN, NEWMARK.

482. **Advanced Numerical Methods in Engineering.** Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures, buckling and flexure of frameworks, torsion of solid and thin-walled sections, lateral buckling of beams, bending of plates and of stiffened plates, plane stress and axially symmetrical problems in elasticity, and other subjects. I or II; 1 to 2 units. Prerequisite: Civil Engineering 481. AUSTIN, NEWMARK.

483. **Analysis and Design of Plates and Shells.** Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design

of reinforced concrete bridge and building floors, highway and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs and hipped plate construction. II; 1 to 2 units. Prerequisite: Consent of instructor. VELETSOS.

484. **Behavior of Structures Under Dynamic Loads.** Free vibrations, forced vibration, and transient response of structures and structural components having one or many degrees of freedom; analytical methods for the effects of wind load, explosion blast, impact, earth tremors, and other time dependent excitations; effects of damping and inelastic action; propagation of stress waves; wind induced vibrations with application to cables, pipelines, and tall stacks. I; 1 to 2 units. Prerequisite: Consent of instructor. VELETSOS.

485. **Behavior of Steel Structures.** Studies of the behavior of metal structures; significance in terms of design and development of specifications; critical evaluations of experimental investigations of columns, beams, and frames loaded to failure; strength of riveted, bolted, and welded connections; brittle fracture; fatigue; and impact. I or II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. MUNSE.

486. **Design of Lightweight Structures.** Analysis and design of structures and structural members of minimum weight. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree with previous work in statically indeterminate structures.

487. **Design of Structures for Dynamic Loads.** Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limited design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast resistant structures; criteria for design of earthquake resistant structures; application to actual problems. II; 1 to 2 units. NEWMARK.

491. **Thesis (M.S.).** I, II; ½ to 2 units.

492. **Thesis (Ph.D.).** I, II; ½ to 4 units.

493. **Special Problems.** Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who supervises the work. I, II; ½ to 2 units.

495. **Highway Seminar.** Presentation and discussion of current problems and research developments in highway transportation, administration, and engineering. Should be followed by Civil Engineering 496. I; no credit. E. DANNER.

496. **Highway Seminar.** Continuation of Civil Engineering 495. Presentation and discussion of current problems and research developments in highway transportation, administration, and engineering. II; no credit. E. DANNER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Photogrammetry.** A study of aerial surveying in civil engineering practice: characteristics and interpretation of aerial photographs; stereovision; mosaics; economics of photogrammetry; map reproduction. Practice in the preparation of a topographic map from aerial photographs. I; ½ unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp); consent of instructor.

319. **Advanced Surveying.** Advanced problems in topographic engineering; control surveys, special mapping projects, construction surveys, and special surveys. The utilization of maps and survey data in civil engineering practice. II; ½ unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp); consent of instructor. SCHMIDT.

323. **Highway Traffic Characteristics.** Driver characteristics, vehicle characteristics, and traffic behavior as related to highway design and operation; traffic studies, field problems. I; 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor. BAERWALD.

324. **Airport Design.** Basic principles of site selection for airports; fundamental considerations of design, construction, and maintenance of airport pavements and structures. II; ½ to 1 unit. Written reports are required of students who register for one unit.

332. **Engineering Properties of Soils.** Laboratory practice in testing, identification, and classification of soils; study of development of test procedures and basic theories involved; calculations and preparation of graphs using test data. Tests include those for classification, determination of physical properties, and job control. I, II; ½ unit. Prerequisite: Consent of instructor. BAUER.

344. **Water and Sewage Treatment.** Principles, design, and operation of water purification and sewage treatment works; correlation of these aspects with various laboratory control tests, their application, interpretation, and limitations as used in practice. I; 1 unit. DIETZ, ENGELBRECHT.

345. **Public Health Engineering.** The application of engineering principles to the control of environmental sanitation, including disease and immunity, epidemiology, biostatics, industrial hygiene, atmospheric pollution, housing, refuse collection and disposal, milk and food sanitation, and plumbing. II; ½ unit. DIETZ, ENGELBRECHT.

351. **Drainage and Flood Control.** Land drainage, river improvement, flood control. II; ½ unit. Prerequisite: Civil Engineering 250. DOLAND.

355. **Water Power Engineering.** Analysis of hydrologic and power market data; selection of site and hydraulic machinery; preliminary design of water passages and power house; formal reports on projects. II; 1 unit. Prerequisite: Civil Engineering 250. DOLAND.

356. **Hydraulic Engineering Laboratory.** Fundamental principles, operation and use of model laboratories, dimensional analysis, hydraulic similitude, theory and design of hydraulic models. II; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. GUILLOU.

359. **River Hydraulics.** Gaging of streams, stream erosion and deposition, use of groins, revetments and mats, stream systems, and river navigation. I; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232. DOLAND, GUILLOU.

361. **Statically Indeterminate Structures.** Elastic theory and its applications to statically indeterminate structures. I, II; ½ unit. Prerequisite: Civil Engineering 262; credit or registration in Civil Engineering 264.

362. **Statically Indeterminate Structures.** I, II; ½ unit. Prerequisite: Civil Engineering 361, or 262 and consent of instructor.

370. **Foundations and Retaining Walls.** Evaluation of subsoil conditions as they affect the behavior, proportions, and choice of type of foundations; relations between foundation and other structural problems; design and construction of retaining walls and abutments including the study of earth pressure theories; applicability of analytical methods used to other problems involving natural phenomena. I, II; ¾ to 1 unit. Special problems are required of students who register for one unit. Prerequisite: Civil Engineering 230 and 263. DAILY.

371. **Earth and Masonry Structures.** Design and construction of gravity masonry dams, earth dams and embankments, rock-fill dams, and the substructure for bridges and buildings. I, II; ½ unit. Prerequisite: Credit or registration in Civil Engineering 264 and 370, or consent of instructor. DAILY.

373. **Soil Mechanics.** Identification, description, and physical properties of soils, subsurface exploration; engineering characteristics of natural deposits of soil. I; 1 unit. DEERE.

374. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; braced cuts and tunnels; damage due to construction operations. II; 1 unit. Prerequisite: Civil Engineering 373. DEERE, PECK.

375. **Engineering Aspects of Surficial Soils.** Use of geologic, pedologic, and air-photo information for identification and evaluation of the engineering properties of surficial soils. II; 1 unit. Prerequisite: Civil Engineering 230 or consent of instructor. THORNBURN.

THE CLASSICS

The Department of Classics offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

The degree of Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the degree of Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. In all cases, the requirement of a master's thesis is waived; extra units of work in Greek or Latin are substituted for the thesis.

The degree of Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

Students applying for admission must have a 3.5 grade-point average for that portion of the work which represents the last 50 per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

All graduate students should take Latin 495-496, Bibliography and Criticism, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a mimeographed bulletin which may be obtained by applying to the head of the department, 126 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: J. L. HELLER (Head of Department), R. P. OLIVER, B. E. PERRY, A. TURYN.

Classics in Translation

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Classical Literary Traditions, I.** Greek literature from Homer to Aristotle. I; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Knowledge of Greek or Latin is not required. PERRY.

302. **Classical Literary Traditions, II.** Literary forms in the Alexandrian and Roman periods. II; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Knowledge of Greek or Latin is not required. HELLER.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading

knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered on demand. Consult the departmental office, 126 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. **Greek Versification.** Greek prosody: survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. I, II; 1 unit.
411. **Hellenistic Literature.** I, II; 1 unit. PERRY.
412. **Lucian and His Age.** I, II; 1 unit. PERRY.
413. **Greek Lyric Poetry.** I, II; 1 unit. TURYN.
414. **Pindar and Bacchylides.** I, II; 1 unit. TURYN.
415. **Homer.** I, II; 1 unit. TURYN.
416. **Thucydides.** I, II; 1 unit. HELLER.
423. **Aeschylus and Sophocles.** I, II, 1 unit. PERRY.
424. **Euripides.** I, II; 1 unit. TURYN.
425. **Greek Drama: Comedy.** I, II; 1 unit. PERRY.
461. **Greek Archaeology.** Methods and principles of Greek archaeology, as exemplified in the study of pottery, sculpture, architectural remains, coins, and inscriptions. I, II; 1 unit. Prerequisite: One year of ancient history or consent of instructor. Knowledge of Greek not required.
491. **Research in Special Topics.** Same as Latin 491. Guidance in writing theses for advanced degrees. I, II; 1 to 4 units. HELLER, OLIVER, PERRY, TURYN.
495. **Bibliography and Criticism.** Same as Latin 495. Introduction to the methods and techniques of scholarship. I; ½ unit. OLIVER.
496. **Bibliography and Criticism.** Same as Latin 496. II; ½ unit. OLIVER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

318. **Elements of Technical Terminology.** Presentation and analysis of Greek and Latin prefixes, suffixes, and root-words basic in the vocabularies of modern science, especially botany, psychology, zoology, and medicine. I, II; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent, or completion of twenty hours of science or architecture. Knowledge of Greek or Latin is not required. HELLER, LEWIS.
391. **Readings in Greek Literature.** Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. I, II; ½ to 1 unit. Prerequisite: Two years of college Greek; consent of instructor. STAFF.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge of French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the degree of Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. At least two of the four required units in Latin must be in courses numbered above 400; the other two units may be chosen in whole or in part from Latin 311, 312, and 391. The required work in education consists of Education 311 and 312 and one unit selected from Education 301, 302, 303, 304. The electives may be in Latin, in Greek, in education, or, in exceptional cases, in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. L. Heller, 126 Lincoln Hall.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered on demand. Consult the departmental office, 126 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is four years of college Latin or equivalent.

409. **History of the Latin Language.** I, II; 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language. HELLER.
410. **Vulgar Latin.** I, II; 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language. HELLER.
411. **Latin Epigraphy.** I, II; 1 unit. Prerequisite: Three years of college Latin or equivalent; one year of ancient history. OLIVER.
412. **Latin Elegy.** I, II; 1 unit. OLIVER.
413. **Caesar.** I, II; 1 unit. TURYN.
414. **Lucan.** I, II; 1 unit. OLIVER.
415. **Lucretius.** I, II; 1 unit. PERRY.
416. **Vergil.** I, II; 1 unit. TURYN.
421. **Horace.** I, II; 1 unit. TURYN.
422. **Plautus and Terence.** I, II; 1 unit. HELLER.
423. **Latin Romance.** I, II; 1 unit. PERRY.
425. **Cicero.** I, II; 1 unit. TURYN.
426. **Tacitus.** The *Annales.* I, II; 1 unit. OLIVER.
427. **Roman Satire.** I, II; 1 unit. PERRY.
441. **Latin Paleography.** I, II; 1 unit. OLIVER.
462. **Topography and Monuments of Ancient Rome.** I, II; 1 unit. Prerequisite: One year of ancient history or consent of instructor.
491. **Research in Special Topics.** Same as Greek 491. Guidance in writing theses for advanced degrees. I, II; 1 to 4 units. HELLER, OLIVER, PERRY, TURYN.
495. **Bibliography and Criticism.** Same as Greek 495. Introduction to the methods and techniques of scholarship. I; ½ unit. OLIVER.
496. **Bibliography and Criticism.** Same as Greek 496. II; ½ unit. OLIVER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Caesar and His Background.** Geography, history, and politics of the age of Caesar. Lectures and readings in the sources. Designed especially for the high school teacher. S; ½ unit. Offered in 1957 and in alternate years. Prerequisite: One year of college Latin beyond the level of four years in high school.
311. **Advanced Latin Composition.** Practice in the writing of Latin prose. I; ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major. TURYN.

312. **Advanced Latin Composition.** II; ½ unit. Prerequisite: Latin 311. TURYN.

313. **Oral Latin.** Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Offered in 1957 and in alternate years. Prerequisite: Latin 312 or consent of instructor.

391. **Readings in Latin Literature.** Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Livy, Horace, Vergil, Cicero's *Orations,* Seneca, Ovid, Cicero's *Essays,* Patristic Latin, Medieval Latin. I, II; ½ to 1 unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction, each calling for a somewhat different undergraduate preparation and graduate program. Students majoring in dairy science may select one of these areas of study for the master's or doctor's degree. Students interested in the economics of milk production normally major in the Department of Agricultural Economics. For the Master of Science degree, students may elect to confine their work entirely to the major. If a minor is chosen, it must be in another department. For the Doctor of Philosophy degree, students may select a sole minor in another department, or a first minor and a second minor, the first of which may be in a field closely allied to the area of specialization of the major; the second must be taken in another department. The amount of graduate credit required in each case is dependent upon the specifications of the Graduate College and the department in which the minor is chosen. Students selecting dairy bacteriology or dairy biochemistry as areas of specialization for the major in dairy science should expect and be prepared to elect some branch of chemistry as one of the minors for an advanced degree.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are admitted on limited status.

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. A faculty adviser specifies course requirements and their sequence and directs the research and the preparation of the thesis. Candidates for the degree of Master of Science must complete one-half unit of Dairy Science 490 and two units of Dairy Science 493. For the degree of Doctor of Philosophy, one and eight units, respectively, of these courses are required. Other course requirements depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the degree of Master of Science are expected to complete an acceptable thesis unless conditions warrant waiver of this requirement, which may be done only upon petition to and permission of the Dean of the Graduate College. All students expecting to continue graduate studies should fulfill the thesis requirement for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science is a departmental requirement for the degree of Master of Science.

For a minor in dairy science, students should select a minor adviser in the area of study of their choice and determine with that adviser the specific courses required. For the degree of Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the degree of Doctor of Philosophy, the minimum requirements for a sole minor are four to six units of dairy science of which three units must be in courses numbered 400 or higher; for a first minor, four units in dairy science; and for a second minor, two units in dairy science.

ASSISTANTSHIPS

Teaching and research assistantships are available each year to candidates for either advanced degree. Most of these assistantships are on a half-time basis and involve a reduced study schedule as outlined in the general regulations of the Graduate College. Inquiries and applications should be addressed directly to the head of the department, 315 Animal Sciences Laboratory.

GRADUATE TEACHING FACULTY

Professors: G. W. Salisbury (Head of Department), K. E. Gardner, R. G. Hansen, N. L. VanDemark.
Associate Professors: K. A. Kendall, W. O. Nelson, R. W. Touchberry, W. A. Wood.
Assistant Professors: R. E. Brown, J. H. Byers, R. L. Hays, B. L. Larson.

COURSES FOR GRADUATES

405. **Economic Milk Production.** II; 1 to 2 units.

408. **Physiology of Lactation.** The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. II; ½ to 2 units. Hays.

411. **Population Genetics and Animal Breeding.** Same as Animal Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals. Results of different systems of mating and the expected gains from different methods of selection. A knowledge of elementary algebra is essential. II; 1 unit. Prerequisite: Dairy Science 110 or equivalent. Touchberry.

30. **Physiology of Mammalian Germ Cells.** A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. II; 1 unit. Prerequisite: Dairy Science 330 or Animal Science 406, and Chemistry 350, or consent of instructor. Salisbury, VanDemark.

50. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. I, II; ½ to 2 units. Prerequisite: Dairy Science 150, 151, and 350. Nelson, Wood.

53. **Dairy Bacteriology Seminar.** Discussion of current literature and problems in dairy bacteriology. II; ½ unit. Nelson, Wood.

50. **Dairy Chemistry.** Assigned problems. I, II; ½ to 2 units. Hansen, Larson.

90. **Dairy Science Seminar.** Current literature relating to various phases of dairy science. I, II; ½ unit. Salisbury.

93. **Research.** Work may be taken in the following subjects: dairy bacteriology, dairy chemistry, dairy cattle breeding, dairy cattle feeding, milk produc-

tion. Graduate students writing a thesis should so indicate when registering. I, II; 1 to 4 units. BROWN, BYERS, GARDNER, HANSEN, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOOD.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Genetics and Animal Improvement.** Same as Animal Science 305. The principles of heredity and their application to the problems of animal improvement. II; ¾ unit. Prerequisite: Dairy Science 110 or equivalent. ROBERTS, TOUCHBERRY.

311. **Problems in Dairy Farming.** Dairy farm operation, including field and building arrangement, cropping systems, herd management, sanitary milk production, and farm marketing problems. Lectures, quiz, assigned readings, and term problems. I; ¾ unit. Prerequisite: Dairy Science 100 and 202.

320. **Special Problems.** I, II; ½ to 1 unit. Prerequisite: Approval of head of department. BROWN, BYERS, GARDNER, HANSEN, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOOD.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. I; ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 101. VANDEMARK.

334. **Marketing Dairy Products.** Same as Agricultural Economics 334 and Marketing 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

340. **Statistical Methods for Biological Research.** Same as Agronomy 340, Animal Science 340, and Horticulture 340. A study of statistical methods as tools for research. When, where, and how to use the methods are stressed along with basic concepts of methodology. I; 1 unit. JACOB.

341. **Designing Experiments for Biological Research.** Same as Agronomy 341, Animal Science 341, and Horticulture 341. Principles of experimental design are discussed and the available designs of simpler forms are studied from the viewpoint of when and how to use them. Specialized applications of experimental designs are taken up. II; 1 unit. Prerequisite: Dairy Science 340 or equivalent. JACOB.

350. **Advanced Dairy Bacteriology.** A systematic study of the cultural, physiological, and biochemical properties of micro-organisms; the application of principles to problems concerning the microflora of milk, milk products, and the bovine digestive system. I; 1 unit. Prerequisite: Bacteriology 104; Chemistry 122 and 132 or equivalent. NELSON, WOOD.

381. **Dairy Biochemical Laboratory Methods.** Theory and application of dairy biochemical laboratory methods: proximate analysis, spectrophotometry, chromatography, protein separation, microtechniques, micro respiration, and others. II; 1 unit. Prerequisite: Quantitative analysis; organic chemistry; consent of instructor. Biochemistry is recommended. HANSEN, LARSON.

ECONOMICS

The Department of Economics offers graduate work leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy.

An applicant's undergraduate grade-point average must be at least 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Students who wish to make economics their major subject for an advanced degree must have had at least twenty-seven hours of undergraduate work in social science, fifteen of which must have been in economics; the work in economics must include a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite. Students in other departments who wish to take a minor in economics must have had at least twelve hours in social sciences, eight hours of which must have been in economics, consisting of a course in principles of economics and other courses for which the course in principles is a prerequisite. Students who cannot meet these requirements may register for graduate work but, unless specifically exempted because of superior scholarship or for other reasons satisfactory to the adviser in charge, must remove any deficiencies during the first year of residence by taking prescribed courses without graduate credit.

A first-year student whose major is economics must take either Economics 400-401 or 402-403. If a minor is taken outside the department, two units of work are ordinarily required. Undergraduate courses approved for graduate credit may be taken in lieu of graduate courses but not for more than a total credit of two units.

A student who wishes to become a candidate for the Doctor of Philosophy degree with a major in economics must pass a preliminary examination showing (1) a detailed knowledge of economic theory and its history; (2) a detailed knowledge of certain special fields of economics or allied fields, the number and selection of which is to be determined by the adviser in consultation with the student; and (3) a general acquaintance with the subject matter and bibliography of other branches of economics. In the work offered in some related field outside the department, the student is expected to satisfy the examiners as to his proficiency in that subject.

A student who chooses economics as a minor for the Doctor of Philosophy degree must take at least two units of work in this department.

ASSISTANTSHIPS

The Department of Economics awards for each academic year a limited number of assistantships to graduate students in economics. These ordinarily provide a stipend of $1,500 plus tuition for half-time teaching or research, or $750 plus tuition for quarter-time service. Under general policy of the department these assistantships are awarded only to those who have master's degrees or the equivalent. In exceptional cases, however, particularly where the scholastic records are outstanding, quarter-time assistantships are granted to persons with no graduate training.

Prospective graduate students in economics who seek assistantships in the department should submit applications not later than March 1 preceding the academic year for which appointment is sought. Requests for application forms and for any additional information regarding these assistantships should be addressed to the chairman of the Department of Economics, 226 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professors: H. K. Allen (Chairman of Department), V. L. Bassie, J. F. Bell, W. E. Chalmers, J. F. Due, D. P. Flanders, H. M. Gray, R. W. Harbeson, D. L. Kemmerer, D. P. Locklin, R. W. Mayer, E. B. McNatt, W. H. McPherson, R. I. Mehr,

W. A. Neiswanger, R. M. Nolen, R. C. Osborn, J. B. Parrish, D. W. Smythe, G. A. Steiner, P. M. Van Arsdell.

Associate Professors: Grace Beckett, H. Brems, R. Ferber, F. B. Haworth, G. Kleiner, J. L. McConnell, D. W. Paden, W. C. Robb, Janet L. Weston, W. Woodruff.

Assistant Professors: R. Brandis, J. A. Cochran, A. S. Hall, R. O. Harvey, C. C. Jones.

Instructors: F. Williams, T. E. Yancey.

COURSES FOR GRADUATES

400. **General Economic Theory.** A preliminary survey of business, labor, government, monetary, and other institutional aspects of economics, followed by a more extended analysis of theoretical economics and the application of this theory to some of the problems raised in the preliminary survey. Intended for students whose minor is economics and other students who have only the minimum preparation for graduate study in economics. I; 1 unit. Prerequisite: Economics 102 and 103, or 108. Flanders.

401. **General Economic Theory.** A preliminary survey of business, labor, government, monetary, and other institutional aspects of economics, followed by a more extended analysis of theoretical economics and the application of this theory to some of the problems raised in the preliminary survey. Intended for students whose minor is economics and other students who have only the minimum preparation for graduate study in economics. II; 1 unit. Prerequisite: Economics 102 and 103, or 108. Flanders.

402. **Economic Theory.** From the fundamentals laid by classical and neo-classical writers, this course develops modern micro-economic and macro-economic theory: demand and cost, market forms, price policy, non-price competition, general equilibrium theory, and input-output analysis. I; 1 unit. Prerequisite: Twenty-seven hours of undergraduate work in social sciences, fifteen of which must have been in economics; the work in economics must include a course in the principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite. Brems.

403. **Economic Theory.** From the fundamentals laid by classical and neo-classical writers, this course develops modern micro-economic and macro-economic theory: employment, wage, interest and monetary theory, the theory of investment, the theory of consumption, the theory of steady advance, and the theory of welfare. II; 1 unit. Prerequisite: Twenty-seven hours of undergraduate work in social sciences, fifteen of which must have been in economics; the work in economics must include a course in the principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite. Brems.

404. **Theory of Aggregate Income.** A comprehensive introduction to the theory of the determinants of the level of aggregate income. I, II; 1 unit. Prerequisite: Consent of instructor. Paden.

406. **A History of Economic Thought.** Development of economic thought from early times to the present. I; 1 unit. Bell.

407. **A History of Economic Thought.** Development of economic thought from early times to the present. II; 1 unit. Bell.

410. **Comparative Economic Systems.** The economics of capitalism, socialism, communism, and fascism. I; 1 unit. McConnell.

414. **Public Finance.** An analysis of the economics of public expenditures, administration of public funds, intergovernmental fiscal relations, non-tax revenues, public borrowing, debt management, and fiscal policy. I; 1 unit. Prerequisite: Six hours of economics. Allen, Due.

415. **Economics of Taxation.** An analysis of the economics of taxation, with respect to distribution of tax burden, incidence of taxation, and the place in the tax system of the major taxes, particularly the personal and corporation income, sales and excise, property, and death taxes. II; 1 unit. Prerequisite: Six hours of economics. ALLEN, DUE.

420. **Monetary Theory and History.** An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. I, II; 1 unit. NOLEN.

428. **International Economics and Finance.** Analysis of international monetary standards; of their effects on domestic income levels, finance, and central bank problems. I; 1 unit. KLEINER.

429. **International Economics and Finance.** Governmental policies designed to maximize domestic welfare through international exchange of goods and services and through international investment. II; 1 unit. KLEINER.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 336. I; 1 unit. KEMMERER.

437. **Research in American Economic History.** Training in principles of historical method and research; application of economic principles to the study of American economic history; the use of bibliographical materials; the use of technical aids to research such as microfilm, tape recorders, and questionnaires. Case method is used. II; 1 unit. Prerequisite: Economics 336 or 436, or equivalent, and a course in economic principles, or consent of instructor. KEMMERER.

438. **Seminar in the Economic History of England Since the Beginning of the Industrial Revolution.** British economic and social history from the rise of industrial society: the land and agriculture; population; the revolution in transportation and communications; the progress of industrial techniques; trade and commercial policy; financial policy; economic fluctuations; the working class movement; the rise of the welfare state; from Empire to Commonwealth. I, II; 1 unit. Prerequisite: Consent of instructor. WOODRUFF.

440. **Labor Economics.** Same as Labor and Industrial Relations 440. A critical economic analysis of contemporary English and American wage theory, employment and unemployment, and collective bargaining, with emphasis on public policy. I; 1 unit. Prerequisite: Six hours of economics. MCNATT.

441. **Labor Economics.** Same as Labor and Industrial Relations 441. A critical economic analysis of contemporary English and American wage theory, employment and unemployment, and collective bargaining, with emphasis on public policy. II; 1 unit. Prerequisite: Six hours of economics. MCNATT.

442. **Problems and Practices in Collective Bargaining.** Same as Labor and Industrial Relations 442. Seminar in the methods and techniques of collective bargaining in the negotiation of the labor contract; nature and significance of labor agreements; union, management, and public interests in major contract provisions. I; 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Labor and Industrial Relations 443. Seminar in the techniques of labor contract administration; comparative study of grievance procedure operation; analysis of conciliation, fact-finding, and arbitration procedures, including case studies of arbitration awards. II; 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

444. **The Labor Market.** Same as Labor and Industrial Relations 444. Basic labor force concepts and measurement; economic theory of market operation and contemporary research; long and short run changes in labor force size, composition, mobility, and participation rates, wartime problems of mobilizing labor resources; international aspects, industrial and military, of differential population and labor force growth; public policy and market operations. I; 1 unit. Prerequisite: Six hours of economics. PARRISH.

445. **The Labor Market.** Same as Labor and Industrial Relations 445. Concepts, sources of materials, methods of analysis, nature of labor supply, nature of labor demand and recruitment; determinants of interplant occupational mobility with emphasis on the wage structure and the role of wages in allocation of labor supply; adjustment to technological change; problems of the older worker; development of market policy by unions and management; development of public policy including employment service and anti-discrimination programs. II; 1 unit. Prerequisite: Six hours of economics. PARRISH.

446. **Trade Unions and the Economy.** Same as Labor and Industrial Relations 446. The economic significance of trade unionism: the role of unions as economic policy making institutions; basic economic criteria in union-management negotiations; union policies and changing technology; unions and social security issues; effect of trade union policies and practices on the functioning of a competitive system. I; 1 unit. Prerequisite: Six hours of economics. PARRISH.

447. **Labor Union Organization and Administration.** Same as Labor and Industrial Relations 447. Analysis of the structure and government of the modern American trade union movement with particular reference to the relation between organization and function. Problems relating to the function and execution of economic policies, the maintenance of unity and discipline, the adjustment of jurisdictional conflicts, and the observance of agreements are examined and appraised. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. CHALMERS, GARMAN.

454. **Corporation Finance.** Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. I; 1 unit. Prerequisite: Economics 254. VAN ARSDELL.

455. **Corporation Finance.** Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. II; 1 unit. Prerequisite: Economics 254. VAN ARSDELL.

456. **Investment.** A study of the financial process by which savings are transformed into capital with emphasis on the theory of investment, on a critique of investment policy, and on the valuation of investment media. I; 1 unit. Prerequisite: Six hours of economics. MAYER.

460. **Economics of Risk and Insurance.** A study of the nature and cost of risk in our economic society and of the methods of handling it. I, II; 1 unit. MEHR.

470. **Economic Statistics.** Basic concepts and methods of statistical analysis as applied in economics and business. I; 1 unit. Prerequisite: Consent of instructor. NEISWANGER.

471. **Economic Statistics.** Methods of analysis, problems of aggregation and index numbers, nature of economic time series and problems of analysis;

input-output analysis and special problems of functional analysis in economics. II; 1 unit. Prerequisite: Economics 470 or nine hours of applied or theoretical statistics. NEISWANGER.

472. **Econometrics.** Same as Mathematics 472. Application of the principles of mathematical statistics to estimation of economic relationships. II; 1 unit. Prerequisite: Mathematics 363; consent of instructor.

473. **Economic Forecasting.** Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgment in evaluating current information; selecting critical factors, and appraising the validity of analytical techniques. II; 1 unit. Prerequisite: One year of statistics. BASSIE.

480. **Seminar in the Relations of Government and Business.** Problems in the relations of government and business. Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. I; 1 unit. GRAY.

481. **Seminar in the Relations of Government and Business.** Problems in the relations of government and business. Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. II; 1 unit. GRAY.

484. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. I; 1 unit. LOCKLIN.

485. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. II; 1 unit. LOCKLIN.

488. **Government Regulation of Economic Activity.** A critical economic appraisal of the objectives and results of government policy and practice in controlling economic activity. I, II; 1 unit. STEINER.

489. **Industrial Competition and Monopoly.** A study of the economic, legal, and public policy problems presented by industrial concentration and by price making in imperfectly competitive markets. II; 1 unit. Prerequisite: A course in principles of economics. HARBESON.

490. **Individual Study and Research.** Directed reading and research. I, II; ½ to 1 unit. STAFF.

492. **Economics Seminar (A.M. and Ph.D.).** Required of all students writing master's and doctor's theses in economics. I, II; 1 to 4 units. Master's theses. FLANDERS. Doctor's theses, ALLEN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Intermediate Economic Theory and Analysis.** A development of the leading theories and analyses of value and distribution. Problems and policies of price determination of both the firm and the industry and factor pricing are presented at the intermediate level of analysis. I, II; ½ unit. Prerequisite: Economics 102 and 103, or 108 and 109. BELL.

301. **Monetary and Employment Theory.** Monetary theory including various versions of the quantity theory of money; the modern theory of the determination of the level of income and employment; theories of money and interest; fiscal and monetary policy; criteria, proposals, critique. I, II; ½ unit. Prerequisite: Economics 250. COCHRAN.

304. **Mathematical Analysis in Economics.** Designed to acquaint the student with rudimentary mathematical techniques and their application to economic analysis. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108 and 109; Mathematics 111 or 112. BREMS.

306. **History of Economic Thought.** A study of the development of economics. Contributions of schools of thought and individual writers are examined as they influenced economic thought and national policy. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. BELL.

313. **Economics of Consumption.** Analysis of population, personal income distribution, consumption theories, savings and price movements; aggregate consumption expenditures and consumer choice; applications in the areas of laws affecting consumers, credit and tax policies. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MILLICAN.

326. **Theories and Policies of International Commerce.** Analysis of international trade theories, classical and recent; international commercial policies, past and current; economic development in selected world regions; international commercial agreements and conferences; foreign trade policy of the United States. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. BECKETT.

328. **Latin-American Economic Problems.** Economic problems of commerce, finance, transportation, mining, agriculture, and industry in Latin America; Latin-American and international economic relationships. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108, or consent of instructor. BECKETT.

329. **Commerce and Industry in South America.** A study of the economic development of the countries of South America. Specialization, characteristics of economic activity, growth of manufacturing; foreign exchange mechanism, balance of payments adjustment, exporting and importing. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; consent of instructor. BECKETT.

335. **American Financial History.** American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banks and of other financial institutions, and the financing of major wars. II; ½ to 1 unit. Prerequisite: Economics 250. KEMMERER.

336. **American Economic History.** Westward movement; growth of industry, agriculture, commerce, finance, transportation, trust movement, and labor. I, II; ½ to 1 unit. KEMMERER.

342. **Economics of Social Security.** Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MCNATT.

343. **Collective Bargaining.** Same as Labor and Industrial Relations 343. Emergence of collective bargaining in American industry; national labor policy and bargaining; impact of bargaining on union and management structures and policies; bargaining processes and techniques; the labor agreement including contract provisions, grievance procedures, arbitration; economic consequences of bargaining; case studies of union-management relationships and problems. II; ½ to 1 unit. Prerequisite: Economics 240. PARRISH.

344. **The Law and Labor.** Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; Economics 240. MCNATT.

346. **Foreign Labor Movements.** Same as Labor and Industrial Relations 346. Analysis of the history, organization, economic policies, political programs

and domestic, international, and contemporary influence of the labor movements of Great Britain, Sweden, Germany, France, Latin America, and Russia. I; ½ to 1 unit. Prerequisite: Economics 240. CHALMERS.

359. **Security Analysis.** Application of investment principles to investment policy; analytical principles and techniques; analysis of fixed income corporate securities, of senior securities with speculative features, of common stocks, of government and municipal securities, and of investment company securities. II; ½ to 1 unit. Prerequisite: Accountancy 108; Economics 254. MAYER.

363. **Advanced Life Insurance.** A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. II; ½ to 1 unit. Prerequisite: Economics 262. MEHR.

366. **Casualty Insurance.** An examination of hazards, contracts, forms, rates, underwriting principles, and loss prevention activities in the following branches of insurance: workman's compensation, public liability, burglary, robbery, theft, glass, power plant, credit, accident and health, and fidelity and surety. I; ½ to 1 unit. Prerequisite: Economics 260. MEHR.

367. **Problems in Insurance.** An analysis of problems dealing with the fitting of insurance coverages to the needs of business. The course considers the problems of surveying hazards, selecting policy forms, rating, underwriting, loss adjustment, loss prevention, and over-all insurance planning. II; ½ to 1 unit. Prerequisite: Economics 263 and 366. MEHR.

368. **Survey of Urban Land Economics.** A broad survey of the field of real estate land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. I; ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor. HARVEY.

369. **Urban Land Problems.** A problems course open to seniors specializing in urban real estate and land economics. A major urban land problem is selected for study. Whenever possible the problem is selected and developed jointly with the Departments of City Planning and Landscape Architecture, Architecture, and others. II; ½ to 1 unit. Prerequisite: Economics 368 or consent of instructor. HARVEY.

370. **Applied Statistical Analysis.** Same as Mass Communications 370. A general course in statistical methods applied to the subject matter fields of the College of Commerce and Business Administration. Intended principally for those students who have entered or intend to enter a program of graduate study and whose training in the basic statistical methods employed in these disciplines is inadequate. Credit is not given for Economics 370 in addition to Economics 271. I; 1 unit. Prerequisite: Admission to candidacy for a graduate degree with no more than one course in economic statistics. NEISWANGER.

371. **Applied Problems in Sampling.** Design of various types of samples useful in economic and business research; cost limitations and design of samples; sources of bias and sampling methods; interpretation of results; practical experience in conducting a complete sampling survey as a class project. II; ½ unit. Prerequisite: Economics 170 or a similar introductory course in statistics.

372. **Operations Research.** Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of probability theory, linear programming, statistical management controls, queuing theory; busi-

ness policy and statistical decisions. I; ½ to 1 unit. Prerequisite: Economics 170 and Management 101, or consent of instructor.

374. **Business Fluctuations and Forecasting.** An analysis of the business cycle and other fluctuations in business activity. Various economic theories, pertinent empirical studies and the historical record are examined to determine causes, to evaluate policy, and to explore methods of forecasting business activity. II; ½ to 1 unit. Prerequisite: Economics 250. PADEN.

375. **National Income and Economic Growth.** National income concepts and measurement. An analysis of the general level of output in the economic system and its distribution among individuals; the use of empirical data in various economic models; the conditions for and the consequences of economic growth. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. PADEN.

377. **Senior Seminar in Statistics.** Deals with statistical problems of general interest in economics and business. The topics are selected to emphasize difficulties of definition, concept, data collection, measurement, and analysis and serve to bring together the theoretical concepts and methodological tools which have been acquired by the student in preparatory courses. II; ½ to 1 unit. Prerequisite: Economics 170 and 271; credit or registration in Economics 371. NEISWANGER and others.

379. **Elements of Econometrics.** The formulation of hypotheses concerning economic relationships, different types of models, the identification and statistical testing of relations, and the efficient computation of numerical estimates. II; 1 unit. Prerequisite: One year each of statistics and economic theory; consent of instructor.

384. **Economics of Transportation.** Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HARBESON, LOCKLIN.

385. **Economic Problems of Commercial Air Transport.** Study of air transport with particular reference to questions of public policy, system of regulation, and regulatory policy. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. LOCKLIN.

386. **Current Transportation Problems.** An analytical and critical study of selected problems of current interest in transportation. II; ½ to 1 unit. Prerequisite: Economics 384. HARBESON.

388. **Economics of National Security.** Analysis of economic aspects of American national security in relation to world problems, economic problems of mobilization, and the impact of national security policies on the economy. Includes problems and policies in the area of industrial production, economic stabilization, manpower allocation, agriculture, foreign economic warfare, military procurement, and facility expansion. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. STEINER.

389. **Industrial Competition and Monopoly.** The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership as alternatives to the antitrust approach. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HARBESON.

390. **Economics of Communications, I.** Same as Journalism 390 and Mass Communications 390. Economic problems associated with the public means of communication: telephone, telegraph, the postal service, the various forms of radio broadcasting including FM, television, and facsimile, and the use of radio for the safety and efficiency of transportation, protective services,

etc. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

391. **Economics of Communications, II.** Same as Journalism 391 and Mass Communications 391. Economic problems associated with the following means of communications: motion pictures, newspapers, magazines, and books. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

EDUCATION

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology, elementary school teaching, guidance and counseling (including rehabilitation counseling), history and philosophy of education, home economics education, industrial education, research methods, secondary school teaching, or school psychology.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher for that portion of work which represents the last sixty semester hours completed to secure the bachelor's degree, exclusive of required physical education and military training, provided also that the undergraduate preparation is appropriate to advanced study in the chosen major field.

Degree of Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College pertaining to admission, registration, programs, degree requirements, grades, residence, majors and minors, foreign language, and theses (see pages 21-23), the following regulations apply to programs leading to the degree of Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of no more than two units (Education 491) is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required of all students. Competence may be demonstrated by satisfactory grades in the required courses or by satisfactory completion of proficiency examinations in those courses. Education 311 and 312 are required. Two courses chosen from Education 301, 302, 303, and 304 are required.

These degrees are usually the first step toward the degree of Doctor of Philosophy in Education. They also satisfy, in part, the requirements for admission to candidacy for the degree of Doctor of Education.

Degree of Master of Science in the Education of the Deaf. For admission to the curriculum for the degree of Master of Science in the Education of the Deaf, one of the following prerequisites is necessary: (1) a bachelor's degree in elementary or special education (other than education of the deaf), or (2) a bachelor's degree in education of the deaf from an accredited training center for teachers of the deaf.

Candidates for the degree must earn a minimum of eight units as follows:

(1) Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required.

(2) For those students qualifying under prerequisite (1), Education 417, one unit; Education 319, one or one and one-half units; Education 320, one to two units; Speech 301, one-half unit; Speech 395, one-half unit; and Speech 385, one-half unit, are required. For those students qualifying under prerequisite (2), Education 418, one unit, and Education 449, one unit, are required.

(3) Elective courses should be chosen from Education 381, 412, 425, 426, 430, 440, 456, 460; Psychology 443, 461; Speech 375, 388, 488, 489.

The advisers for candidates for this degree are Professors S. A. Kirk and O. P. Kolstoe, 1003 West Nevada Street.

Degree of Master of Science in the Education of Mentally Handicapped Children. For admission to the curriculum for the degree of Master of Science in

the Education of Mentally Handicapped Children, the following prerequisites are necessary: courses sufficient to meet the requirements for an Illinois Teacher's Certificate, and the following undergraduate courses: Education 220 and 231, and Speech 208.

Candidates for the degree must earn a minimum of eight units as follows:

(1) Required courses: Education 311, one-half unit; Education 312, one-half unit; two courses chosen from Education 301, 302, and 304, one unit; Education 417, one unit; Education 322, one-half unit; Education 323, one-half unit; Education 426, one unit.

(2) Elective courses should be chosen from Education 390, 411, 412, 433; Psychology 338, 406, 411, 445, 461, 467, 493, 494; Speech 385, 388.

The advisers for candidates for this degree are Professors S. A. Kirk and O. P. Kolstoe, 1003 West Nevada Street.

Degree of Doctor of Philosophy. For general requirements for the degree of Doctor of Philosophy, see page 23. A student who wishes to become a candidate for the degree of Doctor of Philosophy with a major in education must have met (1) the academic requirements for the degree of Master of Arts or Master of Science in Education and (2) have written a thesis. Applicants for admission should present credentials well in advance of the date for their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the student is accepted by an adviser.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Degree of Master of Education.

(1) *Admission.* In addition to general requirements, the work presented for admission must include a minimum of sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

(2) *Residence.* At least four units must be earned while the student is in residence on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

(3) *Individual Programs of Study.* Each candidate for the Master of Education degree works under the direction of a faculty adviser who helps him plan the program of study he will follow. This program must total at least eight units of course work, including four units in education. Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required, except that students who pass proficiency examinations in these courses are excused from this requirement.

There may be one or two minors with a maximum of four units credit. In general, candidates for the Master of Education degree are expected to take at least two units in fields other than education. This provision is especially applicable to students in secondary education. The general requirements governing minors apply except that courses at the 200 level may be recognized for minor credit. Registration for credit in 200-numbered courses is subject to prior approval of the Dean of the Graduate College. Credit is computed at the rate of one-fourth unit for each semester hour, with two units as the maximum allowed for credit in 200-numbered courses. Credit earned in such courses can not be counted to-

ward requirements for the degrees of Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Advanced Certificate in Education.

(1) *Admission.* A master's degree from an accredited institution, plus a minimum of two years professional employment in education with a record of successful performance, constitutes the minimum requirement for admission.

(2) *Residence.* The residence requirement for the Advanced Certificate is similar to that for the Master of Education degree.

(3) *Individual Programs of Study.* A program leading to the Advanced Certificate in Education requires the satisfactory completion of a year of specialized professional study. Of the eight units of course work required at least four must be in courses at the 400 level. Students who have not previously taken Education 311 and 312, or their equivalents, are required to take these courses or pass proficiency examinations on them. A similar provision applies with respect to two courses chosen from Education 301, 302, 303, and 304. The remaining course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education degree. The program that a student proposes to follow must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted as meeting requirements for the Doctor of Education or the Doctor of Philosophy degrees.

Degree of Doctor of Education. Programs leading to the degree of Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

(1) *Admission.* A candidate for admission must hold a master's degree from an accredited institution. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

Applicants for admission should present credentials well in advance of the date for their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the student is accepted by an adviser.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

(2) *Residence.* Minimum residence requirements are (a) two consecutive semesters during each of which a minimum of three units of work is successfully completed or (b) one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

(3) *Program.* A minimum of sixteen units of course work beyond requirements for the master's degree is required. Extramural course work may not be included as part of this sixteen-unit requirement. A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the degree of Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. No more than six units of credit earned at other universities may be included in the minimum sixteen unit requirement.

Education 410, 415, and 496 are required (note prerequisites).

A preliminary examination must be completed satisfactorily prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his admission before he may be admitted to the preliminary examination. The preliminary examination is given by a committee appointed by the Dean of the Graduate College. The nature of the examination is determined by the committee. Part of the examination may be written. Part of it must be oral.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations. The thesis required for the degree of Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

A final oral examination is held at least two weeks prior to the date the degree is conferred. The examination committee is appointed by the Dean of the Graduate College. The final examination is primarily concerned with the report of the thesis study, but also extends over the whole field of the candidate's study. It is designed to determine whether or not the candidate has a thorough and mature understanding of the field of education as a whole.

Degree of Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 217.

GRADUATE STUDY IN SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy degree. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an interne. After an applicant is admitted as a graduate student in the department of his choice, his acceptance and his work in this program are subject to review by the Joint Committee on School Psychology, representing the College of Education and the Department of Psychology.

ASSISTANTSHIPS

The College of Education employs a substantial number of graduate assistants who hold temporary part-time appointments which allow them to devote much of their time to graduate study. Most of these appointments provide for half-time duty; others for one-fourth time. The rate of pay for most half-time assistants is $1,600 for the academic year, or $1,950 for the calendar year, plus exemption from tuition fees in the Graduate College. Since assistantships are offered as a means of facilitating students' programs of graduate study, preference is given to young persons who can provide convincing evidence of ability to do graduate work of superior quality. The majority of these appointments go to candidates for the doctor's degree, but each year a number of places are assigned to begin-

ning graduate students of extraordinary promise. Further information and application forms may be obtained from Professor F. H. Finch, 105 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: B. L. Dodds (Dean of the College of Education), C. M. Allen, A. W. Anderson, D. P. Ausubel, T. E. Benner, G. M. Blair, R. B. Browne, R. W. Burnett, L. J. Cronbach, J. J. DeBoer, G. P. Deyoe, F. H. Finch, C. R. Griffith, H. M. Hamlin, H. C. Hand, J. T. Hastings, K. B. Henderson, M. R. Karnes, W. V. Kaulfers, G. C. Kettelkamp, S. A. Kirk, W. P. McLure, P. V. Miller, T. E. Newland, C. W. Odell, M. M. Ohlsen, E. F. Potthoff, E. H. Reeder, C. W. Sanford, H. A. Schultz, J. H. Shores, R. H. Simpson, B. O. Smith, W. O. Stanley, Celia B. Stendler, M. R. Sumption, J. L. Trump, Letitia Walsh, H. S. Zim.

Associate Professors: F. P. Barnes, R. N. Evans, G. C. Finlay, G. J. Froehlich, N. L. Gage, N. E. Gronlund, M. Horwitz, Ann E. Jewett, C. E. Johnson, R. S. Jones, C. G. Knapp, A. H. Krebs, W. M. Lifton, J. E. McGill, F. McMurray, L. E. Metcalf, C. H. Patterson, L. J. Phipps, R. E. Pingry, F. C. Proff, J. N. Weiss, R. J. Young.

Assistant Professors: J. M. Atkin, J. H. Brochard, W. W. Charters, J. J. Gallagher, O. P. Kolstoe, W. J. Moore, R. A. Tinkham, A. P. Whitney.

Instructors: Eloise Kennedy, J. V. Totaro.

COURSES FOR GRADUATES

401. **Modern Theories of Education.** A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. II; 1 unit. Stanley.

402. **Educational Movements in the Twentieth Century.** An historical study of the more significant educational trends during the past fifty years with special reference to their influence on the problems of American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and an examination of the efforts to solve the problems since 1900. I; 1 unit. Prerequisite: Education 300, or 302, or 403, or consent of instructor. Anderson.

403. **The Historical Foundations of American Educational Thought.** A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. II; 1 unit. Prerequisite: Education 300 or 302, or consent of instructor. Anderson.

404. **Seminar in Educational Classics.** Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. II; 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. Stanley.

405. **Foundations of Group Methods.** A critical study of the ethical, social-psychological, and methodological ideas and problems underlying currently pro-

posed methods for the management and improvement of groups and for training leadership in using these methods, with special attention to the use of such methods in educational settings. The work includes student projects in the management and improvement of educational and action groups. I; 1 unit. Prerequisite: Education 311 and 312; two of the following: Education 301, 302, 303, 304. MILLER.

406. **Seminar in the History of Education.** Intensive group study of a small number of selected problems to assist individual students to develop understanding of and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. ANDERSON.

407. **Logical Foundations of Methods.** A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment, and knowing, examined from the standpoint of recent developments in pragmatism. II; 1 unit. Prerequisite: Consent of instructor. MCMURRAY.

408. **Advanced Philosophy of Education.** An examination of philosophical concepts and issues most closely related to problems in education. Includes readings in the major philosophical writings of John Dewey as well as in other writings representing the more significant current philosophical viewpoints opposed to Dewey's outlook. I; 1 unit. Prerequisite: Advanced graduate standing; consent of instructor. MCMURRAY.

409. **Advanced Philosophy of Education.** Continuation of Education 408. II; 1 unit. Prerequisite: Education 408. MCMURRAY.

410. **Seminar in Theories of Educational and Social Change.** Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. I, II; 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in Education. SMITH, STANLEY.

411. **Psychology of Adolescence for Teachers.** The psychological significance of adolescence, its biological and social foundation, and its implications for education. I, II; 1 unit. Prerequisite: Education 311 and 312. AUSUBEL, BLAIR.

412. **Advanced Child Development for Students of Education.** A consideration of the nature of the child and his development during the pre-school and elementary school years, with emphasis on development as a process of social learning; an interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. I, II; 1 unit. Prerequisite: Education 311 and 312. AUSUBEL, STENDLER.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. II; 1 unit. Prerequisite: Education 311 and 312. GAGE.

414. **The Psychology of College Teaching.** Designed particularly for graduate students minoring in education or preparing for college teaching. Psycho-educational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction analysis, and use of test results and resource materials in this field. I; 1 unit. Prerequisite: A course in psychology; consent of instructor. SIMPSON.

415. **Psychological Theories Applied to Education.** An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. I, II; 1 unit. Prerequisite: Education 311 and 312; Education 411 or 412; candidacy for Ed.D. or Ph.D. in Education. BLAIR.

416. **Problems in Mental Deficiency.** An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis; social, medical, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, anthropology, and psychology to educational theory and practice with reference to the mentally deficient. I; 1 unit. Prerequisite: Education 322 or 323, or consent of instructor. KIRK.

417. **Psycho-educational Problems of Exceptional Children.** A course for teachers, elementary school supervisors, principals, and superintendents, and for supervisors of special education programs. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children, consideration of the special school provisions needed for their education and development, including the social and educational backgrounds of special education programs, the problems of selection of children for special education, teaching procedures, buildings and equipment needed in the programs, legal bases for such programs, financing, and administration. I, II; 1 unit. Prerequisite: Sixteen hours of psychology and/or education, or consent of instructor. KIRK, NEWLAND.

418. **Problems in Communication for the Deaf.** An advanced course in the problems of communications used by the deaf, including the learning of language, reading, speech, and speech reading. Consideration is given to the various methods that are used in the teaching of these basic skills to deaf children and the psychological principles underlying the methods. A critical analysis is made of each topic considered. II; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Education 319 and 320, or equivalent.

419. **Clinical Educational Diagnosis.** A clinical course in the diagnosis of educational disabilities, including reading, spelling, and arithmetic. Practice in the use of diagnostic instruments, interpretation of results, and case studies, with recommended remediation, are emphasized. II; 1 unit. Prerequisite: Education 311 and 312; Psychology 443. KIRK.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, the effects of different handicaps on adjustment to different situations; the somatopsychological significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed on different groups of handicapped children and adults by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. The implications of somatopsychological findings and theories for current educational programs for the handicapped are analyzed. II; 1 unit. Prerequisite: Education 117 and 312, or consent of instructor. NEWLAND.

422. **Basic Principles of Counseling.** Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of edu-

cation and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. I, II; 1 unit. Prerequisite: Education 311 and 312. LIFTON, PROFF.

423. **Use of Tests in Guidance.** Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. II; 1 unit. Prerequisite: Education 392 or equivalent, or consent of instructor. BROCHARD, HASTINGS.

424. **Case Analysis in Guidance.** The nature, synthesis, and use of case data for guidance purposes. Students develop skills in solving typical counseling problems through role playing and other laboratory experiences. II; 1 unit. Prerequisite: Education 422 and 423; consent of instructor. LIFTON, PROFF.

425. **Principles of Guidance.** For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. Students who have taken Education 325 are not allowed credit for Education 425. I, II; 1 unit. FINCH, LIFTON, OHLSEN, PROFF, TOTARO.

426. **Diagnostic and Remedial Programs of the School.** A study of remedial programs in reading, spelling, English, arithmetic, handwriting, and content subjects. I, II; 1 unit. WHITNEY.

427. **Principles and Techniques of Group Guidance.** A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. II; 1 unit. Prerequisite: Education 311, 312, 422, 423, and either 325 or 425; or consent of instructor. LIFTON, OHLSEN.

428. **The Analysis and Use of Occupational Information in Guidance Programs.** Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. I; 1 unit. Prerequisite: Education 325 or 425, or consent of instructor. BROCHARD, OHLSEN.

429. **Field Instruction in Counseling.** Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. I, II; 1 or 2 units. Prerequisite: Education 422 and 424 (with consent of instructor, registration in Education 424 may be concurrent). FINCH, LIFTON, PATTERSON.

430. **Elementary School Organization and Administration.** Intended primarily for elementary school principals and for those who are preparing for the principalship. Such topics as the following are considered: present status of the elementary school principal; classification and promotion of pupils; school records; report cards; plans for student participation in self-government; school-community relationships. II; 1 unit. Prerequisite: Education 431 and 439. MILLER.

431. **Elementary School Classroom Programs.** An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. I, II; 1 unit. MOORE, STENDLER.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered

in the fields of reading and the language arts, social studies, elementary science, and arithmetic. I, II; 1 unit. Prerequisite: Education 431; for the section in reading and the language arts, Education 336, or a course in the teaching of reading or language arts, or consent of instructor; for the section in elementary science, Education 335 and two years of college science, or consent of instructor. ATKINS, JOHNSON, MOORE, REEDER, SHORES.

437. **Methods of Child Study.** A study of ways in which teachers can evaluate child behavior and development. Demonstration, observation, practice. II; 1 unit. Prerequisite: Education 311, 312, and 412.

438. **Supervision of the Elementary School.** Designed for present and prospective supervisors in elementary schools. Considers the purposes of supervision in the context of a democratic theory of learning and teaching. The use of teachers' meetings and of individual supervisory techniques are given special attention. I; 1 unit. Prerequisite: Education 431 and 439. REEDER.

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. I, II; 1 unit. SHORES, SMITH.

440. **Administration and Supervision of Junior and Senior High Schools.** Discussion of practical problems; functions of the principal; teacher participation; personnel records, marks, failures, and promotions; administration and supervision of the curriculum, of guidance programs, of extracurricular activities, and of housing and building programs. I, II; 1 unit. Prerequisite: Education 460 or consent of instructor. SANFORD, TRUMP.

441. **Theory and Practice of Teaching in the Secondary School.** An analysis of teaching from the standpoint of social, psychological, linguistic, and logical factors involved in the teaching of content subjects. Recent developments in linguistic analysis, philosophical analysis, and in the psychology of perception are applied to selected problems of secondary school teaching. Lectures and discussion supplemented by observation of classroom activities. II; 1 unit. Prerequisite: Education 301, 311, and 312. HENDERSON, SMITH.

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. II; 1 unit. YOUNG.

448. **Adult Education.** Development and status of adult education; discovering needs for adult education; policies, organization, administration, finance; planning programs and courses; methods and materials; the literature of adult education; research in adult education. Systematic study of individual problems supplements class work. II; 1 unit. HAMLIN.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. I, II; ½ to 1 unit. No more than two units in Education 449 may be offered toward an advanced degree except by special consent of the Dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refine-

ment of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. II; 1 unit. WALSH.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. I; 1 unit. WALSH.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. II; 1 unit. WALSH.

456. **Curriculum Problems and Trends in Specialized Fields of Secondary Education.** Sections are usually offered in the fields of art education, business education, English, home economics, mathematics, foreign languages, science, social studies, common learnings. Designed to develop an understanding of the function of a specific field of special interest in general education. Applies principles of curriculum construction to the special field. Introduces the student to significant problems, points of view, and trends in the field concerned. Acquaints him with significant research relating to organization, content, and techniques in the fields in question. Students are limited to registration in any two sections in addition to the section on common learnings. I, II; 1 unit. Prerequisite: Education 439. BURNETT, DEBOER, HAND, HENDERSON, KAULFERS, KNAPP, METCALF, SCHULTZ, WALSH.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of business, English, home economics, physical education, mathematics, science, social studies, and common learnings education. Broader areas of emphasis, within which students may work, are extraclass activities, conservation, consumer education, family living, guidance, health, inter-group relations, labor-management relations, and public opinion and propaganda. S; 1 to 2 units. STAFF.

460. **Educational Administration.** Provides the basic common understanding of theory and practice in American educational administration which should be expected of teachers, supervisors, and administrative officers. Not open to students who have taken any of the following courses: Education 461, 462, 464, 465, 466. I, II; 1 unit. BENNER, MILLER.

461. **School Finance.** Designed for advanced graduate study of technical problems in school finance. A critical analysis of emerging patterns of financial support in various states, effect of taxation systems on support patterns, emerging controls and structural features as related to finance, the technology of finance distribution patterns for drafting legislation. Review of research on school finance, a critical analysis of theory of school finance, and introduction to techniques of appraising the influence of financial support upon educational returns. I; 1 unit. Prerequisite: Education 460. MCLURE.

462. **Public School Business Management.** Designed for advanced graduate study of business management of local school systems. Emphasis is on the process of operation through first-hand acquaintance with budget making and execution; management of internal accounts; development of effective record systems; purchase, distribution, and management of supplies; operation and maintenance of school plants; management of auxiliary services such as transportation, cafeterias, health; and general office management. II; 1 unit. Prerequisite: Education 460. MCLURE, MILLER.

464. **Current Problems in School Administration.** Designed to give direct help on local problems, to serve as a refresher course, and to bring the administrator up to date on recent developments in school administration. Open

only to students currently employed as school administrators. S; 1 to 2 units. STAFF.

465. **Public School Finance and Business Administration.** The theory and practice of financing public education in the United States; development of guiding principles in educational finance, trends and needs in state and federal participation in school support, and local operational finance. Not open to students who have completed Education 461 or 462. II; 1 unit. Prerequisite: Education 460. McLURE, MILLER.

466. **Administrative Leadership.** Considers the generalized procedures (based on principles underlying democratic leadership drawn from philosophy, psychology, and sociology) by which the administrator may work with and through people to develop and operate effective educational programs in public school systems. II; 1 unit. Prerequisite: Education 405 and 460. MILLER.

467. **The American College.** Development of the American college and university, public and private; conflicting theories; present trends. II; 1 unit. Not offered in 1956-1957. BENNER.

468. **Public Relations of the Schools.** Study of the interrelationships between the lay community and the schools. Appraisal of procedures, actual or proposed, for the improvement of these relationships. I, II; 1 unit. Not offered in 1956-1957. BENNER.

469. **Legal Basis of School Administration.** The legal rights, privileges, responsibilities, immunities, and authority of pupils, parents, teachers, administrators, and school board members in relation to the school. I; 1 unit. SUMPTION.

471. **Public School Education in Agriculture: Policies and Programs.** Local policies and policy making, organizing agricultural education in a public school system, planning and evaluating programs of agricultural education, lay and professional roles in policy making and program planning, departmental organization and management, facilities for a modern program of agricultural education. I; ½ unit. Prerequisite: Agricultural Education 276 and 277. Open to school administrators without prerequisite. HAMLIN.

472. **Agricultural Education in Secondary Schools.** Place of agricultural education in secondary schools; functions of vocational and nonvocational agriculture; coordination of class work; supervised farming; the F.F.A.; guidance; course planning; teaching procedures and aids; facilities. I; ½ unit. Prerequisite: Agricultural Education 276 and 277. DEYOE.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, adult education in the public schools, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. II; ½ unit. Prerequisite: Agricultural Education 276 and 277. HAMLIN.

474. **Supervised Farming in Vocational Agriculture.** Importance and meaning of supervised farming; evaluation of supervised farming; relation to establishment in farming; selecting and planning farming programs; records; related instruction; supervision; nature of supervised farming for students in day-school, young farmers, and adult farmers classes. I, II; ½ unit. Prerequisite: Agricultural Education 276 and 277. DEYOE.

475. **Organizing and Teaching Farm Mechanics.** Farm mechanics as a phase of vocational education in agriculture; purposes, course planning for high school students, young farmers, and adult farmers, methods of teaching and evaluating, on-farm instruction, planning farm mechanics shops and facilities, pro-

viding and teaching safety in farm mechanics. S; ½ unit. Prerequisite: Agricultural Education 276 and 277. PHIPPS.

476. **Guidance in Agricultural Education.** The guidance function in high school, young farmers and adult farmers classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment in farming, placement, follow-up. S; ½ unit. Prerequisite: Agricultural Education 276 and 277. KREBS.

477. **Field Studies in Agricultural Education.** Planning and introducing new policies, programs, and projects in agricultural education into the schools in which the students are employed. Open to students with at least one year of experience in teaching non-collegiate agriculture who are teaching in Illinois and to Illinois school administrators. I, II; 1 unit. Prerequisite: Agricultural Education 276 and 277. Open to school administrators without prerequisite. DEYOE, HAMLIN.

479. **Education of Teachers of Agriculture.** Critical review of teacher-education programs in operation; recruiting, guidance, and selection of trainees; objectives; evaluation; curricula and courses, student teaching; in-service training; facilities, administration; financing; selection and training of the teacher-education staff. II; ½ unit. Prerequisite: Two graduate courses in agricultural education. DEYOE.

481. **History and Basic Concepts of Vocational Education.** A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. I; 1 unit. KARNES.

482. **Research Studies in Industrial Education.** Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student proposes and completes a brief research, or plans in detail a major research project to be completed later. II; 1 unit. EVANS, KARNES.

487. **Seminar in Industrial Education.** I; 1 unit. EVANS.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses. Study of basic concepts underlying course construction in industrial education. II; 1 unit. Prerequisite: Undergraduate work in industrial education. EVANS, KARNES.

489. **Administration and Supervision of Industrial Education.** Problems and approved practices in the administration and supervision of programs of industrial education in the secondary schools. I; 1 unit. Prerequsite: Undergraduate work in industrial education. KARNES.

490. **Seminar for Advanced Students of Education.** Open only to persons who have been admitted to candidacy for the degrees of Ph.D. or Ed.D. and have completed the preliminary examination. Sections of this seminar are usually offered in the following areas: philosophical and social foundations of education, psychological foundations of education, elementary education, secondary education, educational administration, guidance and counseling, education of the exceptional child, industrial arts and vocational education, agricultural education, and home economics education. I, II; 1 to 2 units. STAFF.

491. **Thesis (Master's).** Individual direction in research and guidance in writing theses. I, II; ½ to 2 units. STAFF.

492. **Thesis (Ph.D.).** Individual direction in research and guidance in writing theses. I, II; ½ to 4 units. STAFF.

493. **Thesis (Ed.D.).** Individual direction in research and guidance in writing theses. I, II; no credit. STAFF.

495. **Theory of Measurement in Education.** The principal theories of test construction and design, psychophysical and psychometric methods of measurement, the criterion problem and techniques of validation, test reliability theory, the theory of measurement as it functions in modern conceptions of educational practice, and the appraisal of educational programs. I; 1 unit. Prerequisite: Education 496; Education 423 or 498. CRONBACH, HASTINGS.

496. **Statistical Methods in Education.** First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and the testing of statistical hypotheses; and other applications of statistics to educational research. I; 1 unit. Prerequisite: Education 390. GAGE, ODELL, PINGRY.

497. **Advanced Statistical Methods in Education.** An advanced course in statistical methods applied to educational research. Statistical estimation, analysis of variance and co-variance, statistical design of experiments, introduction to factor analysis, the use of mathematical models in educational theory. II; 1 unit. Prerequisite: Education 496.

498. **Theory of Educational Evaluation.** Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. II; 1 unit. Prerequisite: Education 496. HASTINGS.

499. **Field Study and Thesis Seminar.** This seminar is usually required of candidates for the degree of Doctor of Education who are taking major work in one of the following areas: philosophical and social foundations of education, psychological foundations of education, elementary education, secondary education, educational administration, guidance and counseling, education of the exceptional child, industrial arts and vocational education, agricultural education, and home economics education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation; tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. I, II; 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

00. **The History of Education.** Brief, introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. I, II; ½ unit. ANDERSON.

01. **Philosophy of Education.** Based on Dewey's *Democracy and Education*, this course is an examination of experimentalist philosophy in its bearings on educational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. I, II; ½ unit. MCMURRAY.

02. **History of American Education.** The development of American education in relation to political, social, and cultural developments. Special attention is given to the influence of movements in the cultural environment upon evolving conceptions of educational theory and practice. I, II; ½ unit. ANDERSON.

303. **Comparative Education.** A study of selected national systems of education in their differing cultural settings. I, II; ½ unit. KAULFERS.

304. **Social Foundations of Education.** An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. I, II; ½ unit. SMITH, STANLEY.

311. **Psychology of Learning for Teachers.** A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understandings. I, II; ½ unit. Prerequisite: Education 211 and practice teaching or teaching experience. BLAIR, CRONBACH, GRIFFITH, GRONLUND, JONES, POTTHOFF, SIMPSON.

312. **Mental Hygiene and the School.** An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. I, II; ½ unit. Prerequisite: Education 211 and practice teaching or teaching experience. BLAIR, GRIFFITH, GRONLUND, JONES, HORWITZ, POTTHOFF, SIMPSON.

315. **Sociology of Education.** Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. I, II; ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. SHIDELER.

316. **The Gifted Child in School and Society.** A consideration of the gifted in society: who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the consideration and evaluation of instructional and administrative adjustments that should be made for the gifted in the educational structure. I; ½ unit. Prerequisite: Psychology 100. NEWLAND.

318. **Workshop and Laboratory in Education of Exceptional Children.** Observation of special laboratory classes of various types of exceptional children; group discussions; conferences with specialists as consultants; work on a project of particular concern to the individual student. S; 1 unit for four weeks; 2 units for eight weeks.

319. **Special Education of the Deaf.** Survey of the curriculum and techniques in pre-schools, kindergarten, and primary and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child. A study of sense training, lip reading, vocabulary development, reading techniques, language and speech development, auditory training, and curriculum construction. I; 1 to 1½ units. Prerequisite: First three years of curriculum for teachers of the deaf, or equivalent.

320. **Special Education of the Deaf.** Continuation of Education 319. II; 1 to 2 units. Prerequisite: Education 319.

321. **Care and Education of Orthopedically Handicapped Children.** Survey of orthopedic handicaps in children, psychological and social effects of such handicaps, and the kinds of schools and services provided for the education of the various types of crippled children. The education of the cerebral palsied child is emphasized. S; 1 unit. Offered in 1956 and in alternate years. Prerequisite: A teacher's certificate or a major in some area of special education.

322. **Psychology and Education of the Mentally Handicapped.** A study of the social, emotional, physical, and learning characteristics of mentally handi-

capped children; methods of diagnosis and differentiation; educational organization and teaching techniques employed for their rehabilitation. I; ½ unit. Prerequisite: Education 231. KIRK.

323. **Psychology and Education of the Mentally Handicapped.** Continuation of Education 322, with emphasis on curriculum. II; ½ unit. Prerequisite: Education 322. KIRK.

324. **Mental and Educational Measurement of Exceptional Children.** Designed primarily to develop an understanding of and ability to interpret the results of psychological and educational tests. Some practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing children who are acoustically, orthopedically, visually, or mentally handicapped, or speech defective. II; ½ unit. Prerequisite: Education 117 or consent of instructor. KIRK, NEWLAND.

325. **Introduction to Guidance and Counseling.** Basic concepts and practices of guidance in schools; what the teacher can do in guidance. Students may not register for credit in both Education 325 and 425. I, II; ½ unit. Prerequisite: Eight semester hours in education and psychology. FINCH, OHLSEN.

335. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the classroom teacher, and the specialist. Opportunity for experience in field and laboratory work. I, II; ½ unit. Prerequisite: Education 101 and 201 or equivalent; two years of college science. ATKIN, ZIM.

336. **Primary Reading.** Critical evaluation of current schools of thought with regard to the teaching of reading and an analysis of the concept of learning as well as the meaning of reading upon which each school is based. Attention is given to reading as a part of the total growth process of the child and to knowledge of methods and materials used in teaching beginning reading. I, II; ½ unit. Prerequisite: Education 101, 201, and 230. MOORE, STENDLER.

337. **Art Education in the Elementary School.** Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. I, II; ½ unit. Prerequisite: Education 101, 201, and 230. SCHULTZ.

354. **Audio-Visual Materials and Problems.** Audio-visual materials are examined from the point of view of their effectiveness and possible utilization in the school program. Recent investigations on materials and methods of presentation are studied to ascertain their pedagogical implications. The technical and administrative problems of integrating audio-visuals into the school curriculum are considered. S; ½ unit. Prerequisite: Education 211, 231, or 241. PETERSON.

370. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meetings in August and November; other meetings in centers in the state convenient to first-year teachers. Visits by instructor to schools in which first-year teachers are employed. I; ½ unit. Prerequisite: Agricultural Education 276 and 277. KREBS, PHIPPS, WEISS.

381. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. I; ½ to 1 unit. EVANS, KARNES.

382. **Organization and Administration of Diversified Occupations Programs.** Designed to provide the specific professional training required of teachers and coordinators who are to conduct programs of diversified occupations in the secondary schools. II; ½ to 1 unit. KARNES.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. II; ½ to 1 unit. EVANS, KARNES.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. S; 1 unit. Prerequisite: Sixteen hours in industrial education. LUX, TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, together with their relationships to other educational agencies. II; 1 unit. EVANS.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. I, II; 1 unit. Prerequisite: Ten hours of undergraduate credit in industrial education. EVANS, KARNES.

390. **Elements of Educational Statistics.** Designed for terminal value for professional training of students not intending to pursue advanced graduate work, and for introductory value for students continuing graduate study in education. Includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. I, II; 1 unit. ODELL.

391. **Construction and Use of Tests in Teaching.** Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking procedure. Designed primarily for classroom teachers. I; ½ to 1 unit. Prerequisite: Education 211. ODELL.

392. **Introduction to the Principles of Measurement.** Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. II; ½ to 1 unit. Prerequisite: Education 211. GAGE.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the degree of Master of Science in Electrical Engineering and Doctor of Philosophy in Engineering is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois in the option in which advanced work is desired. The fields of specialization are physical electronics and electronic engineering, illumination engineering, and power engineering. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering.

An applicant's undergraduate grade-point average must be at least 3.75 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Courses for advanced undergraduates and graduates are also open for credit to students with majors in other departments who have the proper prerequisites.

The objectives of a well-rounded graduate program in electrical engineering may be classified as follows:

(1) Development of a more thorough understanding of the basic fundamentals of electrical engineering.

(2) Development of better tools for the solution of electrical engineering problems.

(3) Uncovering of special characteristics of initiative and resourcefulness.

(4) Development of a specialist's understanding in some area of the electrical engineering field.

An advisory committee of graduate faculty members is appointed for each graduate student who completes the first year of graduate work. This committee and the student work out the graduate study program to be followed. A qualifying examination is ordinarily held in the fall and spring of each year for graduate students who have received the Master of Science degree. The results of this examination are available to the advisory committee as an aid in counseling.

Students in all areas of electrical engineering are required to complete satisfactorily at least one graduate (400) course in the general area of circuits and at least one graduate (400) course in field theory for the Master of Science degree. Students who already have the master's degree must furnish evidence of equivalent training or enroll in such courses in the first year of residence. It is also expected that the student enroll in such additional mathematics work as a review of his training and the field in which he specialized would indicate advisable. Advanced courses in mathematics, physics, chemistry, mechanics, and in other branches of engineering are suggested as suitable minor subjects. A minor sequence in physics to include Physics 381 and 362 is recommended. It is strongly recommended that students who are candidates for the Master of Science degree and expect to continue graduate work elect to write a thesis.

Physical Electronics and Electronic Engineering. It is recommended that graduate students specializing in this field acquire a general knowledge of the whole field as well as a specialized knowledge of some part of it.

For graduate work in communication and electronics, the student should offer the equivalent of the following undergraduate courses: Electrical Engineering 330, 331, 332, and 333, Electrical Machinery; 341, Electronics; 349, Electron Tube Circuits; 351, Networks and Lines; 353, Radio Circuits; 355, Fields and Waves; and differential equations. Students with deficiencies must satisfy these requirements.

Illumination Engineering. The courses in illumination are designed to provide an analytic basis for illumination engineering rather than to develop the theory of light and photometry. Mathematical analysis is applied to illumination design and the answers are compared with the results found in practice.

It is suggested that Electrical Engineering 460 and 461 be taken as early in the program as possible and that the student also include vector analysis during the course of his work. Research work may be in the theory and practice of illuminating engineering or colorimetry.

For graduate work in illumination, the student should offer the equivalent of the following undergraduate courses: Electrical Engineering 320, 321, 322, and 323, Circuit Analysis; 330, 331, 332, and 333, Electrical Machinery; 341, Electronics; 268, Fundamentals of Illumination Engineering; and differential equations.

It is expected that the student will have some preparation in light, physi-
ology, and psychology. Students with deficiencies must satisfy these requirements.

Power Engineering. Graduate work in the power option falls naturally into
the fields of circuits, machinery, and power systems. To provide a suitably broad
base and assure adequate preparation for the courses to follow, it is suggested that
Electrical Engineering 440, 442, and 444 be taken as early in the program as
possible.

For graduate work in power, a student should offer the equivalent of the following undergraduate courses: Electrical Engineering 334, 335, 336, 337, 338, 339, Electrical Power Apparatus; 341, Electronics; and differential equations. Students with deficiencies must satisfy these requirements.

The courses listed below indicate by their content the general field to which they belong. It is recognized that the candidate for the master's degree would not take all of the courses in a particular field, while a candidate for the doctor's degree might expand the listing through a study of special problems. To add broadness as well as depth to his program, a student should include some courses which are not in his chosen option.

For information concerning applied mathematics, see page 28.

FELLOWSHIPS

Industrial fellowships are awarded to qualified graduate students in electrical engineering upon recommendation of the department. Some are restricted to students interested in a specific area or field. Application is made in the same way as for University fellowships. At the present time the following industrial fellowships are available: Galvin Fellowship, sponsored by Motorola, Inc. of Chicago, Westinghouse Educational Foundation Fellowship, Radio Corporation of America Fellowship, Sperry Gyroscope Company Fellowship, Texas Instrument Fellowship in Solid State Physics.

These fellowships ordinarily carry a stipend of at least $1,500 for the academic year and tuition fees are waived.

GRADUATE TEACHING FACULTY

Professors: E. C. Jordan (Head of Department), L. B. Archer, J. Bardeen, W. L. Emery, W. L. Everitt, M. A. Faucett, G. H. Fett, W. J. Fry, L. Goldstein, H. N. Hayward, M. S. Helm, C. A. Keener, J. O. Kraehenbuehl, R. E. Meagher, V. H. Rumsey, H. M. Von Foerster, N. Wax, J. E. Williams.

Associate Professors: G. E. Anner, D. S. Babb, A. D. Bailey, P. D. Coleman, P. R. Egbert, F. E. Hohn, H. W. Horn, M. S. McVay, W. E. Miller, T. A. Murrell, P. F. Schwarzlose, C. E. Skroder, M. E. Van Valkenburg, H. D. Webb, E. K. Weise.

Assistant Professors: W. G. Albright, J. A. Barkson, M. H. Crothers, C. E. Drumheller, R. H. Du Hamel, P. E. Mayes, J. E. Robertson.

COURSES FOR GRADUATES

400. **Seminar.** Required of all graduate students. I, II; no credit. Jordan.

410. **Engineering Analysis.** Static and dynamic field problems with emphasis on the relationships between the various branches of engineering and the development of the use of mathematics as a tool in the solution of complex problems. I, II; 1 unit. Bailey.

412. **Advanced Engineering Measurements.** Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. I, II; 1 unit. Hayward.

413. **Servomechanisms and Automatic Control Devices.** Fundamental theory of servomechanisms and other automatic control devices, electrical analogies, stability, transfer functions, and on-off mechanisms. I, II; 1 unit. Fett.

414. **Foundations of Electrical Network Theory, I.** Formulation and study of foundation axioms of electrical networks, topological basis of mesh and node methods, mesh and node equations by means of matrix transformations, and general proofs of standard network theorems. I, II; 1 unit.

415. **Foundations of Electrical Network Theory, II.** A detailed study of the response of lumped electrical networks by matrix transformation of the generalized mesh and node methods. II; 1 unit.

416. **Advanced Circuit Analysis.** Fundamentals of network theory and theorems, transients, Laplace transform, and the complex frequency concept. I, II; 1 unit. McVay, Van Valkenburg.

418. **Electric and Magnetic Fields.** Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. I, II; 1 unit. Emery.

419. **Dynamic Network Analysis.** Extension of static network theory to networks having relative motion between elements, with particular emphasis on the analysis of rotating electrical apparatus when considered as an integral part of complex control systems. I, II; 1 unit. Prerequisite: Electrical Engineering 416.

420. **Electromagnetic Waves and Radiating Systems.** Fundamental electromagnetic theory with applications to transmission lines, wave guides, and antennas. I, II; 1 unit. Jordan, Rumsey.

421. **Advanced Electromagnetic Engineering.** Huyghen's principle; uniqueness and reciprocity theorems; Babinet's principle; reaction concept; variational methods; applications to plane, cylindrical, and spherical wave problems. Application to a general method of calculating the result of any practical measurement such as antenna radiation pattern and impedance, the parameters of wave guides and cavities, and observations on scattering and diffraction. I, II; 1 unit. Prerequisite: Electrical Engineering 420. Rumsey.

422. **Advanced Communication Networks.** Fourier integral and matrix algebra, analysis of networks, and network synthesis for wide band operation. I, II; 1 unit. Skroder.

423. **Electron and Ion Dynamics.** Laplace equation, conformal transformations, Poisson's equation with initial velocities and transit time, electron optics, and electron ballistics of klystrons and magnetrons. I, II; 1 unit. Prerequisite: Credit or registration in Electrical Engineering 420. Wax.

424. **Theory of Gaseous Discharge Devices.** Motion of ions and electrons; ionization and deionization; space charge and plasma; glow and arc discharges; circuit interruption; arc extinction problems. I, II; 1 unit. Goldstein.

426. **Electroacoustical Systems.** A study of the solutions of differential equations of wave motion with applications to vibrating strings, membranes, rods, sonic systems, loud speakers, microphones, galvanometers. I, II; 1 unit. Fry.

427. **Boundary Value Problems.** Derivation and solution of partial differential equations and integral equations of mechanics and electricity and magnetism; study of the analysis of wave motions. I, II; 1 unit. Coleman.

428. **Nonlinear Oscillating Systems.** Criteria for stability of nonlinear oscillations; nonlinear resonance; study of analytical methods; harmonics and subharmonics, and relaxation oscillations. I, II; 1 unit. Fett.

429. **Vacuum Tube Circuit Analysis.** Vacuum tube network theory, feedback circuits and amplifiers, stability, equalizers, and relations between components of network functions. I, II; 1 unit. Fett.

430. **Gas Tube Circuit Analysis.** Equivalent circuit of gas tubes at low and high frequencies, circuit analysis, and rectifiers. II; 1 unit.

431. **Microwave Circuits.** Four-terminal networks and transmission line theory, bilinear transformations, wave guides, the generalized impedance concept, expansion of fields in normal modes, resonant cavities, and measurement techniques. I, II; 1 unit. Prerequisite: Electrical Engineering 420. EMERY.

432. **Network Synthesis: Image-Parameter Method.** A study of the image-parameter method of synthesizing a four-terminal network (filter and equalizer) which has a prescribed insertion loss. I; 1 unit. MCVAY.

433. **Transmission of Information.** II; 1 unit. Prerequisite: Electrical Engineering 422. WAX.

435. **Conduction of Electricity in Solids.** Same as Physics 435. Application of quantum principles to conduction of electricity in solids, impurity and intrinsic semiconductors, Hall and thermoelectric effects, photoconductivity, p-n junctions, and rectifying contacts, theory and characteristics of transistors. II; 1 unit. Prerequisite: Physics 381 or Electrical Engineering 425 or consent of instructor. BARDEEN.

436. **Applied Electrodynamics.** Tensor form of Maxwell's equations, special relativity, radiation reaction, integration of wave equations. Fourier analysis of radiation fields, Lagrange and Hamiltonian equations. Applications to submillimeter wave generation, Cerenkov effect, radiation from particle accelerators, electron bunching at high energies. II; 1 unit. Prerequisite: Electrical Engineering 420 and 423. COLEMAN.

440. **Advanced Power Circuit Analysis, I.** Special methods of polyphase circuit analysis, transients in multiple loop lumped constant circuits by differential equations and by Heaviside expansion theorem, and study of circuits having nonlinear parameters by step-by-step method. I, II; 1 unit. HELM.

441. **Advanced Power Circuit Analysis, II.** Transients in multiple loop lumped constant circuits by Fourier integral and by Laplace transforms, and study of steady state relations and transients in distributed constant circuits. I, II; 1 unit. Prerequisite: Electrical Engineering 440. HELM.

442. **Advanced Analysis of Alternating Current Machinery.** Steady state analysis of synchronous machines, round rotor and salient poles, magneto-motive forces with symmetrical and unsymmetrical windings, torque angle characteristics, vibration, and noise. I, II; 1 unit. KEENER.

443. **Analysis of Dynamo Machines Under Transient Conditions.** Analysis of the operation of alternating and direct current machines under transient conditions, armature and field phenomena and mutual reactions of dynamo machines with system transients. I, II; 1 unit. Prerequisite: Electrical Engineering 442. KEENER.

444. **Advanced Power System Analysis.** Electrical and mechanical properties of transmission systems, calculations of fault currents, power diagrams, and power limits. I, II; 1 unit. Prerequisite: Electrical Engineering 440. FAUCETT.

445. **Power System Transients and Stability.** Steady state power limits, criteria for loss of synchronism, effects of voltage regulation, exciters, and steady state as influenced by dynamic stability. I, II; 1 unit. Prerequisite: Electrical Engineering 444. FAUCETT.

446. **Electrical Design (Apparatus).** Properties of materials, field mapping, leakage fields, cooling and rating of apparatus, limitations affecting design, prediction of operating characteristics, and special design problems. I, II; 1 unit. ARCHER.

447. **Electrical Design (Power System).** Sources of energy, location of generating stations, selection of units, location of transmission lines, layouts of systems, and extension of established systems. I, II; 1 unit. FAUCETT.

451. **Network Synthesis.** A study of methods for the synthesis of networks for prescribed driving-point or transfer characteristics. I; 1 unit. Prerequisite: Mathematics 345. VAN VALKENBURG.

452. **Network Synthesis.** A continuation of Electrical Engineering 451. II; 1 unit. Prerequisite: Mathematics 345. VAN VALKENBURG.

453. **Automatic Feedback Control System Synthesis.** Synthesis of automatic feedback control systems through pole-zero configurations. II; 1 unit. Prerequisite: Electrical Engineering 413 and 451. VAN VALKENBURG.

461. **Methods of Illumination Calculations.** Fundamentals of the light field, illumination in space, the light vector, plots of fields, and applications of light fields to engineering problems. I, II; 1 or 2 units. KRAEHENBUEHL.

462. **Colorimetry in Illumination.** Color, vision, color of sources, surfaces and filters, direct measurements, measurements of spectral distributions, methods of computing tristimulus values and chromaticity coefficients, color temperature, color systems and their interrelation, linear and homogeneous transformation, color discrimination, and harmony and applications. I, II; 1 unit. KRAEHENBUEHL.

463. **Advanced Illumination Sources.** General theory of enclosures, analytical consideration of simple forms, enclosures in photometry, coefficients applied to enclosures, comparison of calculated and applied methods. I, II; 1 or 2 units. HORN.

464. **Advanced Illumination Design.** Design of lighting equipment for both utility and comfort, control of glare through proper brightness contrasts, design for special applications, and design of floodlighting and streetlighting equipment. I, II; 1 or 2 units. HORN.

491. **Thesis.** I, II; ¼ to 4 units. STAFF.

493. **Research.** I, II; ½ to 4 units. STAFF.

497. **Electrical Engineering Problems.** Special electrical engineering problems. I; ½ to 2 units. STAFF.

498. **Electrical Engineering Problems.** Special electrical engineering problems. II; ½ to 2 units. STAFF.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

20. **Circuit Analysis.** Detailed and analytical solution of periodic current circuits; networks and network theorems; coupled circuits. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 126; Physics 108; credit or registration in Electrical Engineering 321 and in Mathematics 341, 342, 343, or 345.

21. **Circuit Laboratory.** To accompany Electrical Engineering 320. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 320.

22. **Circuit Analysis.** Continuation of Electrical Engineering 320. Wave analysis; three-phase circuits; three-phase power and energy measurements; symmetrical components analysis; filters; transients. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 323.

23. **Circuit Laboratory.** To accompany Electrical Engineering 322. I, II; 0 to ¼ unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 322.

7. **Theory of Measurements.** Precise measurement of electrical quantities and the application of measurement theory to engineering problems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322.

0. **Electrical Machinery.** Transformers and polyphase induction motors. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 322 and 323; credit or registration in Electrical Engineering 331.

331. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 330. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 330 .

332. **Electrical Machinery.** Synchronous machines, single-phase motors, direct-current machines, application. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 330 and 331; credit or registration in Electrical Engineering 333.

333. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 332. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

334. **Electrical Power Apparatus.** Single- and three-phase transformers. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 322 and 323; credit or registration in Electrical Engineering 335.

335. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 334. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 334.

336. **Electrical Power Apparatus.** Synchronous and induction generators and motors. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 334 and 335; credit or registration in Electrical Engineering 337.

337. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 336. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 336.

338. **Electrical Power Apparatus.** Direct-current generators and motors, converters, single-phase motors, frequency changers, duty cycles. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 336 and 337; credit or registration in Electrical Engineering 339.

339. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 338. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 338.

341. **Electronics.** High-vacuum and gas-filled electron tubes, circuits and applications. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321.

347. **Industrial Electronics.** Feedback systems, rectifiers, amplifiers, controls, elements of design. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 341; credit or registration in Electrical Engineering 330 or 334.

349. **Electron Tube Circuits.** Linear and nonlinear amplifiers, fundamentals of modulation and detection, oscillators, rectifiers. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322, 323, and 341; credit or registration in Electrical Engineering 353.

351. **Networks and Lines.** Reactance networks, general transmission line equations, low-loss lines, reflections. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 322.

353. **Radio Circuits.** Impedance transformation, reactance network synthesis as applied to radio frequencies; modulation theory; principles of receivers and transmitters. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322, 341, and 351; credit or registration in Electrical Engineering 349.

355. **Fields and Waves.** Theory of UHF and microwave generators; electromagnetic fields, radiation and propagation of electromagnetic energy, radiating systems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 349 and 351.

360. **Engineering of the Illumination Surround.** Consideration of the factors controlling the quality of the lighting installation with special emphasis on

brightness distribution, glare, seeing, contrast, fatigue, color and color contrast. I; 0 to ½ unit.

361. **Elements of Illuminating Engineering Design.** Application of the fundamentals of optics and light to developments in the design of illumination equipment and lighting installations. I, II; 0 to ½ unit. Prerequisite: Mathematics 132 and 142; Physics 108.

362. **Principles of Illuminating Engineering.** Concept and units in light calculations; calculation of illumination from point, line, and surface sources; interpretation of photometric and test data. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 260; credit or registration in Electrical Engineering 363; Mathematics 345; Physics 270 or Electrical Engineering 360.

363. **Illumination and Photometry Laboratory.** Photometry and illumination measurements. I; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 362.

364. **Illumination Design and Economics.** Design of lighting systems for natural and artificial illumination; applications for interiors and exteriors in both commercial and industrial installations; economic studies; design of reflectors and lighting equipment. II; 0 to ¾ unit. Prerequisite: Electrical Engineering 362 and 363; credit or registration in Electrical Engineering 365.

365. **Illumination Design Laboratory.** To accompany Electrical Engineering 364. Checking and constructing equipment and installation designs in lighting. II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 364.

366. **Illumination Sources.** Study of natural and artificial light sources covering combustion, incandescent, and gaseous lamps, with emphasis on fundamental laws; radiation measurements and colorimetry. II; 0 to ½ unit. Prerequisite: Credit or registration in Electrical Engineering 364 and 365.

376. **Power Circuit Analysis.** Advanced analysis of circuits used for power transmission and distribution. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321.

377. **Machine Application and Control.** Analysis of electrical machinery applications; controls. II; 0 to 1 unit. Prerequisite: Electrical Engineering 336 and 337; credit or registration in Electrical Engineering 338.

378. **Fundamentals of Power Transmission Engineering.** Fundamentals of electrical and mechanical design of power transmission systems. I, II; 0 to 1 unit.

379. **Power Transmission.** Advanced analysis of electrical power transmission systems, faults, stability; network analyzer studies. II; 0 to ¾ unit. Prerequisite: Electrical Engineering 336, 337, and 378.

381. **Pulse Techniques.** Response of electrical systems to repeated transients. I, II; 0 to 1 unit.

382. **Transistor Circuits.** Introduction to circuit properties of point-contact and junction transistors and diodes; linear and nonlinear transistor circuits. With laboratory. Credit is not given for both Electrical Engineering 382 and 383. II; 1 unit. Prerequisite: Electrical Engineering 349 or equivalent course in electron tube circuits.

383. **Transistor Circuits.** Introduction to circuit properties of point-contact and junction transistors and diodes; linear and nonlinear transistor circuits. No laboratory. Credit is not given for both Electrical Engineering 382 and 383. II; ¾ unit. Prerequisite: Electrical Engineering 349 or equivalent course in electron tube circuits.

384. **Logical Design of Automatic Digital Computer Circuits.** Same as Mathematics 384. A course in the design of automatic digital computers. Major

emphasis on logical structure of components and the interrelations necessary for automatic operation. I, II; 1 unit. Prerequisite: Consent of instructor.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. II; 0 to 1 unit.

387. **Electrical Design.** Fundamental principles of electrical power apparatus design with particular application to transformers and generators. Properties of materials in common use; construction of coils; magnetic attraction; stored energy, field mapping; heat dissipation; temperature rise and rating of apparatus. For students selecting the option in power. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 332 and 333; registration in Electrical Engineering 334 and 335.

388. **Electronic Analog Computers.** Design of analog computer elements, problem preparation, and representative solutions of physical problems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 341 and Mathematics 345, or consent of instructor.

389. **Communication Design.** Design, construction, and complete test of a radio transmitter or receiver. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 349 and 353.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric)

Students who enter graduate work with English as their major subject must have attained a grade-point average of 3.75 or higher during the last 50 per cent of their undergraduate work. All students must present the equivalent of at least fourteen hours of undergraduate work in English or American literature, not including required college work in rhetoric. They must also present the equivalent of four semesters of college work in Latin, Greek, French, or German, or, lacking such credit, make good the deficiency before receiving the master's degree. (Four semesters of college Spanish are accepted only from candidates for the Master of Arts in the Teaching of English, not from candidates for the Master of Arts in English.) It is suggested that undergraduate work in English is best distributed in the following way to provide a foundation for graduate study: (1) historical surveys of English and American literature; (2) a course or courses in major writers, e.g., Chaucer, Shakespeare, Milton, Whitman, Melville, etc.; (3) period courses in the Renaissance, seventeenth, eighteenth, nineteenth, or twentieth centuries; (4) courses in literary types, e.g., the novel, poetry, drama. Students are also urged to offer courses in history and philosophy that are pertinent to an understanding of literature.

Students who have as undergraduates made English their minor may be admitted to such courses as in the judgment of the instructors in charge they are qualified to pursue.

Degree of Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates for the degree of Master of Arts in English are required to choose at least four of their courses from those at the 400 level. They must also give evidence that they have taken the equivalent of at least two years of undergraduate work in French, German, Latin, or Greek. They may do this (1) by presenting evidence that they have satisfactorily completed two years of undergraduate study in either language, (2) by passing the reading examination for the doctorate in either language, or (3) by taking and passing with a grade of C either French 400 and 401 or German 400 and 401.

Candidates must also pass a qualifying examination. This is a three-hour written examination devised to test the student's knowledge of and interpretive skill in such English and American literature as an undergraduate English major

may reasonably be expected to have acquired. The examination is given during the first week of each semester and of the summer session. It must be taken during the student's first semester of residence. As a guide to prospective candidates, it is suggested that the following undergraduate courses best fit the pattern of the examination: (1) a course in a major writer, e.g., Chaucer, Shakespeare, Milton, or Melville; (2) a course in a period of literature, e.g., the Renaissance or the eighteenth century; (3) a course in a literary type, e.g., drama, satire, or novel; and (4) surveys of English and American literature. Preparation for the examination should involve a review of the history of English and American literature, emphasizing the major works and major authors of various periods. Some experience in the critical and interpretative evaluation of literature, particularly poetry, is especially desirable.

A master's thesis is not required, although a student may elect to offer one with the approval of his adviser.

Degree of Master of Arts in the Teaching of English. Candidates for the degree of Master of Arts in the Teaching of English must earn four units in English, at least two of them in courses at the 400 level, and they must pass the same qualifying examination as is required for the degree of Master of Arts in English. They must also give evidence that they have taken the equivalent of at least two years of undergraduate work in French, German, Latin, Greek, or Spanish.

Specific requirements are English, four units (students who intend to teach in junior college should take Rhetoric 480); education, two units, including two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in English and the electives must be selected with the approval of the head of the department. The electives may be in English, in education, or, in exceptional cases, in other subjects. Candidates for this degree should consult Professor J. N. Hook, 121 Lincoln Hall.

Degree of Doctor of Philosophy.

English 400. All entering graduate students who intend to proceed beyond the master's degree are required to take English 400, Introduction to Advanced Graduate Study, during one of their first two semesters in residence, summer session not included.

Foreign Languages. Each student is required to demonstrate proficiency in French and German, but with the approval of the adviser and of the head of the department he may petition the Dean of the Graduate College to be allowed to substitute Latin or Greek for one of these languages. Students should pass at least one of their language examinations by the end of the first academic "year."

Adviser. Each student is assigned an adviser upon first registering as a graduate student in English; this adviser directs the whole course of his graduate program until he has passed the preliminary examination. After he has passed this examination, his adviser is the professor who directs his dissertation.

Minor Subjects. Students may offer either a double minor, which includes philology and one other subject, or a sole minor in philology.

If the student elects the former option, he takes English 401, Old English: Anglo-Saxon; 402, Old English: Beowulf; and 403, History of the English Language, in satisfaction of the requirements for the first minor. The second minor consists of at least two units in philosophy, history, or a foreign literature (French, German, Greek, Italian, Latin, Spanish). Under exceptional circumstances the student may be permitted by the head of the department to offer a subject other than one of these for his second minor.

If the student elects the latter option he takes English 401, 402, and 403; the unit chosen from German 426, French 475 and 476; and one unit chosen from these courses or English 411 or 415.

Philology Examination. Each student must pass a comprehensive examination

in English philology at least one term before he takes his preliminary examination. This examination is given in October and May of each year.

Preliminary Examination. The preliminary examination is given in October and May of each year. It consists of two parts:

(1) The written examination. Each student takes written examinations in four of the following periods: English literature before 1500, English literature in the sixteenth century, English literature in the seventeenth century, English literature in the eighteenth century, English literature in the nineteenth century, American literature before 1865, American literature after 1865. These examinations last from three to four hours each and are given on successive days. No student is given an oral examination until he has passed all of his written examinations.

(2) The oral examination covers (a) the four areas chosen for the written examination, (b) the sole or second minor, and (c) in a less intensive form, the remaining areas of English and American literature.

Thesis. The student writes a dissertation under the direction of a graduate professor who also serves as his adviser.

FELLOWSHIPS AND ASSISTANTSHIPS

Applications for teaching assistantships in freshman rhetoric should be sent to Professor Charles W. Roberts, Chairman of Freshman Rhetoric, 204a Lincoln Hall.

Forms for Graduate College fellowships should be secured from the Dean of the Graduate College.

GRADUATE TEACHING FACULTY

Professors: G. N. Ray (Head of Department), T. W. Baldwin, E. H. Davidson, G. B. Evans, J. T. Flanagan, H. F. Fletcher, R. A. Gettmann, M. T. Herrick, J. N. Hook, P. N. Landis, B. A. Milligan, C. W. Roberts, R. W. Rogers, A. W. Secord, R. M. Smith.

Associate Professors: A. D. Culler, M. S. Goldman, A. G. Holaday, S. Paul, C. H. Shattuck.

Assistant Professors: Margaret French, B. Harkness, G. P. Haskell, Cornelia Kelley, E. G. Mathews, H. F. Robins, A. L. Scott, G. B. Stillwell.

English Literature

COURSES FOR GRADUATES

400. **Introduction to Advanced Graduate Study.** A consideration of the methods of literary scholarship, the objectives of literary criticism, and the profession of college English teaching. Required of all candidates for the degree of Doctor of Philosophy in English. I; ½ unit. Gettmann, Ray, Rogers.

401. **Old English: Anglo-Saxon.** An introduction to the language before 1000 A.D. I; 1 unit. Smith.

402. **Old English: Beowulf.** II; 1 unit. Prerequisite: English 401. Smith.

403. **History of the English Language.** A study of the development of the language from the earliest stages to the present time. I; 1 unit. Smith.

411. **Chaucer and His Times.** A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. I; 1 unit. Smith.

412. **Chaucer and His Times.** Continuation of English 411. II; 1 unit. SMITH.

415. **Middle English.** Introduction to middle English dialects, with special emphasis on the East Midland. II; 1 unit. Offered in 1956-1957 and in alternate years. SMITH.

417. **English Literature from the Norman Conquest to 1400.** Primarily literature written in Latin and French (read in translation). I; 1 unit.

418. **English Literature from the Norman Conquest to 1400.** Continuation of English 417. II; 1 unit.

420. **Medieval Latin: Anglo-Latin Writers.** Study of the English writers of the Middle Ages who wrote in Latin; reading of selections in the original. II; 1 unit. Prerequisite: A reading knowledge of classical Latin.

421. **Literature of the Sixteenth Century.** I; 1 unit. BALDWIN.

422. **Literature of the Sixteenth Century.** Continuation of English 421. II; 1 unit. BALDWIN.

425. **Seminar in Spenser.** A study of special problems relating to the works of Edmund Spenser, his background in England and in Ireland, and the second half of the sixteenth century. I or II; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: English 326 or any course in the sixteenth century. SMITH.

427. **Development of Tudor Drama.** I; 1 unit. BALDWIN.

428. **Development of Tudor Drama.** Continuation of English 427. II; 1 unit. BALDWIN.

431. **Shakespeare and Elizabethan Drama.** I; 1 unit. BALDWIN.

432. **Shakespeare and Elizabethan Drama.** Continuation of English 431. II; 1 unit. BALDWIN.

433. **Seminar in Elizabethan Drama.** II; 1 unit. BALDWIN.

434. **Elizabethan Drama.** The immediate predecessors and early contemporaries of Shakespeare to 1603, exclusive of Shakespeare and Johnson. II; 1 unit. Offered in 1956-1957 and in alternate years. BALDWIN.

435. **Literature of the Seventeenth Century.** I; 1 unit. FLETCHER.

436. **Literature of the Seventeenth Century.** Continuation of English 435. II; 1 unit. FLETCHER.

441. **Seminar in Milton and His Age.** I; 1 unit. Prerequisite: English 435 and 436; second-year graduate standing. FLETCHER.

442. **Seminar in Milton and His Age.** Continuation of English 441. II; 1 unit. Prerequisite: English 435 and 436; second-year graduate standing. FLETCHER.

445. **Literature of the Eighteenth Century.** I; 1 unit. SECORD.

446. **Literature of the Eighteenth Century.** Continuation of English 445. II; 1 unit. SECORD.

451. **Studies in the History of the Eighteenth Century Novel.** I; 1 unit. SECORD.

452. **Studies in the History of the Eighteenth Century Novel.** Continuation of English 451. II; 1 unit. SECORD.

455. **Seminar in the History and Theory of Prose Fiction.** I; 1 unit. Prerequisite: Second-year graduate standing. GETTMANN.

456. **Seminar in the History and Theory of Prose Fiction.** Continuation of English 455. II; 1 unit. Prerequisite: Second-year graduate standing. GETTMANN.

459. **The Romantic Movement.** I; 1 unit. GETTMANN.

460. **The Romantic Movement.** Continuation of English 459. II; 1 unit. GETTMANN.

463. **Victorian Literature.** I; 1 unit. CULLER, RAY.

464. **Seminar in Victorian Literature.** II; 1 unit. Prerequisite: English 463. CULLER, RAY.

475. **Studies in Bibliographical Method.** Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. I or II; 1 unit. Prerequisite: Consent of instructor. EVANS.

480. **Background Materials for High School Teachers of English.** Investigation of the content that is desirable in high school literature and composition. S; 1 unit. HOOK.

492. **Research in Special Topics (Thesis).** Guidance in writing theses for advanced degrees. I, II; ¼ to 4 units. BALDWIN, EVANS, FLETCHER, GETTMANN, GOLDMAN, HERRICK, HOLADAY, HOOK, LANDIS, LARSEN, MATHEWS, MILLIGAN, RAY, ROBERTS, ROGERS, SECORD, SMITH, STILLWELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Chaucer.** I; ½ to 1 unit. STILLWELL.

313. **Introduction to the Literature of the Middle Ages.** The literature of western Europe from 1000 to 1500. The literary background, the lyric poetry, and the literature of the castle. I; ½ to 1 unit.

314. **Introduction to the Literature of the Middle Ages.** The literature of western Europe from 1000 to 1500. The literature of the cloister and the tavern. II; ½ to 1 unit.

325. **English Literature from 1588 to 1660.** A survey of English literature during the Renaissance. Sidney, Marlowe, Donne, Jonson, Herrick, Bacon, Burton, and other writers. II; ½ to 1 unit. MILLIGAN.

326. **Spenser.** I or II; ½ to 1 unit. GOLDMAN.

336. **English Drama Exclusive of Shakespeare.** From 1600 to 1700. I, II; ½ to 1 unit. HERRICK.

337. **Studies in Shakespeare.** Nine plays. Special attention given to the modern critical approach and to the principal Shakespearean critics. S; ½ to 1 unit. Prerequisite: English 131 or equivalent; consent of instructor. EVANS.

338. **Tragedy.** Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. I, II; ½ to 1 unit.

342. **The Poetry of Milton.** Origins, forms, artistic and ethical values; Milton's place in English literary history. II; ½ to 1 unit. FLETCHER.

345. **The Metaphysical Poets.** Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughan, Crashaw), with special emphasis on the poetry of John Donne. I or II; ½ to 1 unit. EVANS, MILLIGAN.

346. **The Age of Dryden.** A study of Restoration literature, dramatic and nondramatic, centered around Dryden. I; ½ to 1 unit. EVANS.

347. **Alexander Pope.** Pope's prose and poetry together with selections from Pope's classical models (in translation) are read and discussed in an effort to promote understanding and appreciation of neo-classical ideals and expressions in England. II; ½ to 1 unit. ROGERS.

349. **Dr. Johnson and His Circle.** The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan. Lectures establish the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. I, II; ½ to 1 unit. ROGERS.

351. **The Mid-Victorian Novel.** Thackeray, Charlotte Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. II; ½ to 1 unit. RAY.

355. **Survey of English Literature.** From the beginning to 1700. I, II; ½ to 1 unit. FRENCH, HOLADAY, MILLIGAN, ROGERS.

356. **Survey of English Literature.** From 1700 to 1900. I, II; ½ to 1 unit. FRENCH, HOLADAY, MILLIGAN, ROGERS.

363. **Introduction to Comparative Literature.** Same as German 363. A comparative study of great books in Greek, Roman, Italian, and Spanish literature. I; ½ unit. ALLEN, LANDIS, VAN HORNE.

364. **Introduction to Comparative Literature.** Same as German 364. A comparative study of great books in French, German, and English literature. II; ½ unit. JACOB, LANDIS, SCHUMANN.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as Speech 371. I; ½ to 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as Speech 372. II; ½ to 1 unit. HERRICK.

382. **The Plays of Bernard Shaw.** I; ½ to 1 unit. SHATTUCK.

383. **English Literature in the Twentieth Century.** An introductory survey emphasizing Shaw, the Edwardian novelists, Yeats, Joyce, Lawrence, Eliot, the Bloomsbury group, the satirists of the twenties, and such recent writers as Auden, Orwell, and Graham Greene. I; ½ to 1 unit. HARKNESS, RAY.

American Literature

COURSES FOR GRADUATES

437. **Studies in American Literature: 1600 to 1800.** Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Enlightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. I; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: A survey course in American literature or consent of instructor.

439. **Problems in American Literature and Cultural History.** A conference and research course devoted to intensive studies in the relation of selected writers and problems in American literature to critical movements. I; 1 unit. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN.

440. **Problems in American Literature and Cultural History.** Continuation of English 439. II; 1 unit. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN.

492. **Research in Special Topics (Thesis).** Guidance in writing theses for advanced degrees. I, II; ¼ to 4 units. DAVIDSON, FLANAGAN, HASKELL, KELLEY, PAUL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

415. **The American Drama.** An historical survey of the American drama from the beginning to Clyde Fitch, including the reading of a large number of representative plays. I; 1 unit. Offered in 1956-1957 and in alternate years. FLANAGAN.

416. **The American Drama.** An historical survey of the American drama from Clyde Fitch to the present, including the reading of a large number of representative plays. II; 1 unit. Offered in 1956-1957 and in alternate years. FLANAGAN.

318. **The American Novel: Cooper to Norris.** I, II; ½ to 1 unit. DAVIDSON, HASKELL.

352. **American Literature: Irving to Whitman.** A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. I or II; ½ to 1 unit. DAVIDSON, PAUL.

353. **Studies in Middle Western Literature.** A survey of Middle Western literature from about 1825 to Dreiser, with special emphasis on the development of realism in poetry and fiction. I; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

354. **Studies in Middle Western Literature.** A survey of Middle Western literature from Dreiser to the present, with special emphasis on the development of realism in poetry and fiction. II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

357. **Folklore in American Literature.** A study of American folklore, including folk tales, themes, and characters, with special references to the appearance of such material in American fiction, poetry, and drama. I; ½ to 1 unit. FLANAGAN.

375. **Henry James and the Technique of Fiction.** A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. I; ½ to 1 unit. Prerequisite: Consent of instructor. KELLEY.

376. **American Criticism and American Culture.** This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. II; ½ to 1 unit. Prerequisite: English 113 and 114 or English 255 and 256. PAUL.

380. **Mark Twain and the Rise of Realism.** A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900. II; ½ to 1 unit. SCOTT.

381. **The Twentieth Century American Novel.** Dreiser, Fitzgerald, James, Hemingway, Lewis, Anderson, Dos Passos, Wolfe, Faulkner, and Steinbeck. I; ½ to 1 unit. SCOUFFAS.

Rhetoric and Composition

COURSES FOR GRADUATES

480. **The Theory and Practice of English Composition.** An examination of modern prose style and a consideration of problems confronting writers and teachers of writing at the college level. I, II; 1 unit. ROBERTS.

ENTOMOLOGY

The Department of Entomology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. A prerequisite for graduate work in entomology is a grade-point average of at least 3.5 during the last two years of undergraduate training, exclusive of required physical education and military training. Students are not admitted on limited status. In addition, two years of undergraduate work in biology including zoology and entomology are required.

A candidate who chooses entomology as a major for an advanced degree must have had at least six hours of undergraduate credit in entomology. A reading knowledge of either French or German is required by the beginning of the second year of graduate study.

There are four chief fields of specialization in the department: general entomology (including morphology and taxonomy), insect bionomics, economic entomology (including medical entomology, insect control, and toxicology of insecticides), and insect physiology.

If a sole minor is elected it must involve four units outside the department in one of the following areas: agronomy, bacteriology, botany, including plant pathology, chemistry, horticulture, physiology, and zoology. A first minor (two units) may be taken in a field of specialization in entomology other than the major, and the second minor (two units) must be in a related subject outside the department.

The department is well equipped to offer work in these areas and the facilities of the State Natural History Survey are also available for advanced study. Outstanding entomological library facilities are located on the campus.

Candidates for the master's degree must write a thesis and pass an oral examination covering the general field of entomology. At the option of the faculty, a written examination may also be required.

Candidates for the degree of Doctor of Philosophy in Entomology must pass examinations in two foreign languages and the usual oral preliminary examination before entering the last year of residence. At the preliminary examination a candidate must exhibit a broad background in the whole field of entomology and a knowledge of general biological principles. Candidates should pursue a course of independent private study to include such fields as the history of biology, zoology, and entomology; the philosophy of science; biological literature and biological statistics.

Theses required for the master's and doctor's degrees are due in the office of the Department of Entomology ten days before the date of the oral examination. During this ten-day period theses are available for reading and correcting by faculty members in order that suggested changes may be made in them before they are delivered to the Dean of the Graduate College.

FELLOWSHIPS AND ASSISTANTSHIPS

A number of University fellowships are available in the Graduate College. For a description of application procedures, stipends, and requirements, refer to the beginning section of this catalog.

Three half-time teaching assistantships are available in the department.

Several half-time research assistantships are available through research grants of the United States Public Health Service, the Army Quartermaster Corps, United States Navy, the Surgeon General's office, and the Rockefeller Foundation. These require service of twenty hours a week, and the remaining time is spent in graduate study. These provide varying stipends for nine months or twelve months service and exemption from fees. These assistantships are for work in the fields of insect physiology, medical entomology, and insecticides.

In the Division of Economic Entomology of the Illinois State Natural History Survey, three half-time assistantships are available for control studies of economic insects. These carry various stipends and fee exemption.

For information concerning assistantships in the Illinois State Natural History Survey, write Professor George C. Decker, 123 Natural Resources Building. For application blanks and information concerning assistantships, write the head of the Department of Entomology, 303 Harker Hall. Fellowship application blanks are available from the Dean of the Graduate College.

GRADUATE TEACHING FACULTY

Professors: L. E. Chadwick (Head of Department), W. V. Balduf, G. C. Decker, G. S. Fraenkel, W. R. Horsfall, C. W. Kearns, V. G. Milum, H. H. Ross.

COURSES FOR GRADUATES

407. **External Insect Anatomy.** A comparative study of the external anatomy of various orders of insects. I; 1 unit.

408. **Internal Insect Anatomy.** A comparative study of the internal anatomy of various orders of insects. II; 1 unit. Prerequisite: Entomology 407.

421. **Insect Physiology, I.** Lecture. Deals mostly with the biochemical aspects of the subject: the functions of digestion, respiration, metabolism, excretion, blood and circulation, cuticle, and hormones. I; ½ unit. Prerequisite: A course in organic chemistry; consent of instructor. Fraenkel.

422. **Insect Physiology, II.** Lecture. Deals mostly with the biological aspects of the subject: the functions of nutrition, muscles, nerves, sensory reactions, and behavior. II; ½ unit. Prerequisite: One course in organic chemistry; consent of instructor. Fraenkel.

423. **Insect Physiology, I.** Laboratory experiments with emphasis on biochemical aspects: the functions of digestion, respiration, metabolism, excretion, blood and circulation, cuticle, and hormones. I; ¾ unit. Prerequisite: A course in organic chemistry; consent of instructor. Fraenkel.

424. **Insect Physiology, II.** Laboratory experiments with emphasis on the biological aspects: the functions of nutrition, muscles, nerves, sensory reactions, and behavior. II; ¾ unit. Prerequisite: One course in organic chemistry; consent of instructor. Fraenkel.

426. **Seminar in Entomology.** Discussions, reviews, and appraisals of current literature in the various fields of entomology. I, II; ¼ unit. Prerequisite: One year of entomology or biology.

494. **Research.** Work may be taken in the following subjects: morphology and embryology of insects, economic entomology, systematic entomology, biology and ecology of insects, insect physiology. I, II; ½ to 4 units. Balduf, Chadwick, Decker, Fraenkel, Horsfall, Kearns, Milum, Ross.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Special Problems.** For students ready to take up some special investigation which may be completed as an undergraduate study or the beginning of a thesis problem for an advanced degree. May also be used to prepare a thesis for scholastic honors. I, II; ¼ to 1 unit. Prerequisite: Any of the following: Entomology 131, 308, 309, 310, 313, 317, 318, 319, 320, 322, or Zoology 101 or 321. Balduf, Chadwick, Decker, Fraenkel, Horsfall, Kearns, Milum, Ross.

308. **Insect Pests of Field Crops.** II; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Entomology 101.

309. **Morphology and Taxonomy of Immature Insects.** A study of the structures of nymphs, larvae, and pupae. Devoted to morphological studies which are followed by taxonomic studies in Entomology 310. I; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Consent of instructor.

310. **Morphology and Taxonomy of Immature Insects.** A study of the taxonomy of nymphs, larvae, and pupae. A sequence to Entomology 309. II; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Entomology 309.

311. **Insect Taxonomy.** A one-semester course in the classification of insects designed for biology teachers, for students in agriculture, game management, conservation, zoology, and for those in entomology who can not register for both Entomology 317 and 318. Some of the laboratory time is spent studying and collecting insects in the field. An insect collection is made and identified. S; 1 unit. Prerequisite: Entomology 101 or 103, or a course in biology. BALDUF.

312. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelations with the other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent. BALDUF, HORSFALL.

313. **Medical and Veterinary Entomology.** Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of diseases among men and domestic animals. I; ½ or 1 unit. Prerequisite: Entomology 101 or 103, or Zoology 320. HORSFALL.

316. **Advanced Economic Entomology.** A consideration of the principles underlying ways and means of preventing injury to crops and various products. II; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Entomology 101 or 103. HORSFALL.

317. **Classification of Insects.** Orders with gradual metamorphosis and principles of systematic entomology: the distinctive structural features of the orders comprising the Ametabola and Heterometabola; comparison of various systems of classification of the orders; how to recognize the more common families; practice in keying to species. The principles embrace sources of material, segregation, preparation of keys, descriptions, bibliographies, and outlines for revisional papers. I; 1 unit. Prerequisite: Entomology 101 or 103, or equivalent. BALDUF.

318. **Classification of Insects.** Orders with complete metamorphosis and principles of systematic entomology: distinctive structural features of the orders comprising the subclass Holometabola; comparison of the various systems of classification of the orders; how to recognize the more common families; practice in keying to species; literature; biographies. II; 1 unit. Prerequisite: Entomology 101 or 103, or equivalent. BALDUF.

319. **Chemical Control of Insects.** Discussion and actual practice in the most effective control measures for insect pests; training for professional or commercial work as an entomologist, pest control supervisor, or agricultural agent. II; 1 unit. Prerequisite: Entomology 101 or 103, or a course in economic entomology. KEARNS.

320. **Chemistry and Toxicology of Insecticides.** Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. I; ½ unit. Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. KEARNS.

322. **Insect Bionomics.** This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. Includes an optional four hours of laboratory. II; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Entomology 101 or 103, or Zoology 320. HORSFALL.

FOOD TECHNOLOGY

(Including Dairy Technology)

The Department of Food Technology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in both Food Technology and Dairy Technology.

Students undertaking graduate work in either dairy or food technology must have a grade-point average of at least 3.5 in the last two years of undergraduate work, exclusive of required physical education and military training. Students admitted on a grade-point average below 3.75 are accepted only under the condition that their records are subject to departmental review after they have completed four units of work and that determination of their acceptability to continue on an advanced degree program is made at that time.

A student planning to take a major or minor in dairy technology should have had previous training as an undergraduate in this field. It is also desirable for the student to have had a course in statistics, advanced undergraduate training in mathematics and chemistry, and at least a year of French or German.

Minors may be selected from the following fields of study: economics, agricultural economics, business organization and operation, chemistry, bacteriology, physics, nutrition, veterinary medicine, and dairy production. Requirements for the minors are established by the respective departments concerned.

To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350, Dairy Technology 401 (one unit), 404 (one unit), and 493 (two units). A course in statistics is also necessary unless such a course was taken by the student when an undergraduate. The remainder of the eight units required for the Master of Science degree can be taken in the major and minor fields.

Candidates for the degree of Doctor of Philosophy in Dairy Technology should complete the requirements for their minors by the end of the second year of residence so that the last year can be spent in research on their thesis problems (Dairy Technology 493). Each candidate is required to pass a written examination at the end of the second year of residence but before the oral preliminary examination for the doctorate.

Second-year and third-year graduate students are expected to attend all seminars (Dairy Technology 404) in dairy technology, but they can register for a maximum of only one unit of credit.

A student planning to take a major or minor in food technology should have a Bachelor of Science degree in food technology or in a major field of chemistry, bacteriology, chemical engineering, horticulture, or other recognized field of biological, physical, agricultural, or engineering science in which a minimum of the undergraduate credits are as follows: biology, six hours; physics, eight hours; calculus, five hours; bacteriology, five hours; analytical chemistry, five hours; organic chemistry, five hours; physical chemistry, four hours; and food technology or equivalent, twenty hours. Deficiencies in any of these requirements may be made up during the first year of graduate study, but no graduate credit is given.

To obtain a graduate degree in food technology, a student must have credit (graduate or undergraduate) in Bacteriology 308, Chemistry 329 and 350, and Food Technology 301, 302, 421 (M.S., one-half unit; Ph.D., one unit), and 493 (M.S., two units; Ph.D., eight units). Minors may be selected from the fields of physical, biological, agricultural, or engineering science, and must be approved by the department.

Research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing.

Candidates for the master's degree must complete one language requirement (German, French, or Spanish) and one minor (minimum one unit) and are required to take an examination covering the field of general food technology

and of their specialization. This is primarily an oral examination although at the option of the faculty it may include a written section.

Candidates for the degree of Doctor of Philosophy in Food Technology must complete two language requirements (German and French or Spanish) and must have at least one minor subject. If a sole minor, a minimum of four units must be earned or, if accompanied by a second minor, a minimum of two units in each minor. The formal course work should be completed by the end of the second year in residence so that the last year can be spent in research on the thesis problem. A comprehensive written qualifying examination covering the general field of food technology and the minor fields of study is given after the student has completed sixteen units of graduate work and has satisfied the two language requirements. The results of this examination serve the adviser as a guide in determining the student's readiness to appear for the preliminary oral examination. The thesis must be in the office of the Department of Food Technology ten days before it is due in the Graduate College office.

Graduate credit courses offered outside the Department of Food Technology may be applied in partial satisfaction of the major unit requirements. These may be selected from closely related fields of study, such as bacteriology, chemistry, physics, engineering, and applied biological sciences, and are subject to the approval of the major department.

FELLOWSHIPS AND ASSISTANTSHIPS

The Department of Food Technology has industrial or institutional fellowships and research and teaching assistantships, varying in number from year to year. These are open to all students entering graduate study. Applications for fellowships or assistantships should be made directly to the Department of Food Technology, 213 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: R. T. Milner (Head of Department), E. O. Herreid, L. B. Howard, P. H. Tracy.

Associate Professors: F. A. Kummerow, A. I. Nelson, Z. J. Ordal, S. L. Tuckey, R. M. Whitney.

Assistant Professors: M. P. Steinberg, J. Tobias, L. D. Witter.

Food Technology

COURSES FOR GRADUATES

404. **The Technology of Fats and Oils.** Lectures, reference readings, and demonstrations on the factors involving the technology of fats and oils. II; ½ unit. Prerequisite: Food Technology 391. Kummerow.

406. **The Technology of Fats and Oils.** Laboratory, reference readings, and demonstrations on the factors involving the technology of fats and oils. II; ½ unit. Prerequisite: Credit or registration in Food Technology 404. Kummerow.

421. **Seminar.** Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food technology. I, II; ½ unit. Staff.

481. **Advanced Studies in Food Technology.** Library or laboratory assignments on specific problems of limited scope involving individual commodities or processes. I, II; ½ to 2 units. Staff.

93. **Research.** I, II; ½ to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, and dehydrating. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. I; 1 unit. Prerequisite: Food Technology 201 and 260, or equivalent. NELSON.

302. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats and poultry products; and vacuum and freeze drying of foods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. II; 1 unit. Prerequisite: Food Technology 202 and 301, or equivalent. NELSON.

332. **Principles of Sanitation in the Processing and Handling of Foods.** Same as Veterinary Pathology and Hygiene 332. A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and microorganisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulations. Local field trips to food processing plants. II; ½ unit. Prerequisite: Bacteriology 104 and Chemistry 132, or equivalent. ORDAL, WITTER.

363. **Introduction to Process Engineering.** Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food technology; not open to majors in chemical engineering. Lectures and problems. I; ¾ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Chemistry 340 or 342; one year of calculus. GARVER.

373. **Advanced Food Microbiology.** A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. I; 1¼ units. Prerequisite: Bacteriology 308 and Chemistry 133, or equivalent. ORDAL, WITTER.

391. **The Technology of Fats and Oils.** Lectures, reference readings, and demonstrations on the factors involving the technology of fats and oils. I; ½ unit. Prerequisite: Credit or registration in Chemistry 350 or consent of instructor. KUMMEROW.

393. **The Technology of Fats and Oils.** Laboratory exercises and demonstrations of factors involving the technology of fats and oils. I; ½ unit. Prerequisite: Credit or registration in Food Technology 391. KUMMEROW.

Dairy Technology

COURSES FOR GRADUATES

401. **Advanced Principles of Dairy Technology.** Study of fundamentals and fundamental problems involved in the processing of milk and milk products. II; 1 unit. Prerequisite: Chemistry 350. HERREID.

403. **Colloid Phenomena of Dairy and Other Food Products.** A study of the colloidal phenomena involved in the processing of dairy and other food products. I; 1 unit. Prerequisite: Chemistry 249. WHITNEY.

404. **Seminar.** Review of current literature in dairy technology. Students may register for credit only twice for a maximum of one unit. I, II; 0 to ½ unit. TRACY.

491. **Assigned Problems in Dairy Technology.** Research on special problems for graduate students with a major interest in dairy technology. I, II; ½ to 2 units. STAFF.

493. **Thesis.** I, II; ½ to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Plant Management.** Problems in the organization, financing, labor management, and operation of dairy plants. II; ½ unit. TRACY.

310. **Dairy Product Processing.** Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, and ice cream. II; 1 unit. Prerequisite: Dairy Technology 101, 211, and 213. HERREID, TOBIAS.

311. **Dairy Product Processing.** Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter, butter oil, cheese, dried milk, casein, lactic acid, lactose, and fermentation products of whey. I; 1 unit. Prerequisite: Dairy Technology 211 and 213. TOBIAS, TUCKEY.

312. **The Chemistry of Milk and Milk Products.** Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. II; ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 213 or Chemistry 122. WHITNEY.

FRENCH

(Including Russian)

The Department of French offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Students with a minimum grade-point average of 3.5 or above in the last two years of undergraduate work, exclusive of required physical education and military training, are regularly admitted to graduate courses in French, subject to fulfillment of other prerequisites. Students may be accepted on limited status according to the individual case.

Students electing French as a major subject should have had the equivalent of at least four years of French in college, including practical work in the use of the language and an advanced course in literature. Some knowledge of other Romance languages and literatures is desirable. A basic knowledge of Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Degree of Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates for the degree of Master of Arts in French must pass an examination based on a general reading list. Candidates preparing to teach French take French 407, 409, and 410 unless they can demonstrate proficiency.

Degree of Doctor of Philosophy in French. Candidates for this degree are required to include French 475 and 476, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject.

Degree of Master of Arts in the Teaching of French. Candidates for the degree of Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 407, 409, and 410, two units; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective

courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields. The grade-point average is the same as that required by the department for admission. Students are not admitted on limited status. The adviser for candidates for this degree is Professor J. F. Jackson, 226 Lincoln Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

In addition to University fellowships, for which application should be made to the Dean of the Graduate College, a small number of half-time assistantships are available in the department. These permit a distribution of work between teaching and graduate study. Application should be made to the head of the department, 234 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: C. A. Knudson (Head of Department), J. F. Jackson, J. R. Smiley, P. A. Wadsworth.
Associate Professors: C. C. Gullette, P. E. Jacob, P. Kolb, C. P. Viens.
Assistant Professors: R. E. Hallowell, Frances F. Sobotka.

COURSES FOR GRADUATES

400. **Beginning French for Graduate Students.** Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. degree. I, II; no graduate credit.

401. **Reading French for Graduate Students.** Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. degree. I, II; no graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

407. **Advanced French Diction.** Training in the improvement of French pronunciation, with special attention to the problems of teachers. It is recommended that this course and French 409 be taken simultaneously. I; ½ unit. Knudson.

409. **The Phonetics of French.** A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 407 be taken simultaneously. I; ½ unit. Knudson.

410. **Advanced Syntax.** An advanced theoretical and practical study of present-day French, with some consideration of stylistics. Conducted in French. II; 1 unit. Knudson.

431. **History of Old French Literature, I.** Lectures on the history of French literature from the eleventh through the thirteenth century, with particular attention to epic and romance. Illustrative reading in translation. I; ½ unit. Offered in 1957-1958 and in alternate years. Knudson.

432. **History of Old French Literature, II.** II; ½ unit. Offered in 1957-1958 and in alternate years. Knudson.

433. **Villon, Rabelais.** I; 1 unit.

434. **Montaigne, La Pléiade.** II; 1 unit.

435. **Seventeenth Century Literature, I.** I; 1 unit. Offered in 1957-1958 and in alternate years. Wadsworth.

436. **Seventeenth Century Literature, II.** II; 1 unit. Offered in 1957-1958 and in alternate years. Wadsworth.

437. **Eighteenth Century Literature, I.** I; 1 unit. Offered in 1956-1957 and in alternate years. Wadsworth.

438. **Eighteenth Century Literature, II.** II; 1 unit. Offered in 1956-1957 and in alternate years. WADSWORTH.

447. **Nineteenth Century Literature to 1850, I.** I; 1 unit. Offered in 1956-1957 and in alternate years. JACKSON.

448. **Nineteenth Century Literature to 1850, II.** II; 1 unit. Offered in 1956-1957 and in alternate years. JACKSON.

453. **French Realism and Naturalism, I.** I; 1 unit. Offered in 1957-1958 and in alternate years. JACKSON.

454. **French Realism and Naturalism, II.** II; 1 unit. Offered in 1957-1958 and in alternate years. JACKSON.

457. **Seminar in Proust, I.** I; ½ unit. Offered in 1957-1958 and in alternate years. KOLB.

458. **Seminar in Proust, II.** II; ½ unit. Offered in 1957-1958 and in alternate years. KOLB.

465. **La Littérature Contemporaine, I.** In French. Poetry: Baudelaire; symbolism up to Valéry. Prose writers from 1900 to 1940. I; 1 unit. Offered in 1956-1957 and in alternate years. JACOB.

466. **La Littérature Contemporaine, II.** II; 1 unit. Offered in 1956-1957 and in alternate years. JACOB.

475. **Old French Philology, I.** Reading of characteristic masterpieces of medieval French literature and study of the development of the Old French language from Latin. I; 1 to 1¼ units. Offered in 1956-1957 and in alternate years. Prerequisite: Consent of instructor; elementary knowledge of Latin; reading knowledge of German. KNUDSON.

476. **Old French Philology, II.** II; 1 to 1¼ units. Offered in 1956-1957 and in alternate years. Prerequisite: French 475. KNUDSON.

491. **Research and Thesis.** I, II; 1 to 4 units. JACKSON, JACOB, KNUDSON, KOLB, SMILEY, WADSWORTH.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The prerequisite for all courses in this group is French 201 and 202, or equivalent.

309. **Survey of French Literature, I.** I; ¾ unit. JACKSON.

310. **Survey of French Literature, II.** II; ¾ unit. JACKSON.

317. **Modern French Drama, I.** I; ½ unit. Offered in 1957-1958 and in alternate years. VIENS.

318. **Modern French Drama, II.** II; ½ unit. Offered in 1957-1958 and in alternate years. VIENS.

323. **French Drama of the Seventeenth and Eighteenth Centuries, I.** I; ¾ unit. Offered in 1956-1957 and in alternate years. KOLB.

324. **French Drama of the Seventeenth and Eighteenth Centuries, II.** II; ¾ unit. Offered in 1956-1957 and in alternate years. KOLB.

331. **French Novel of the Nineteenth Century, I.** From Balzac to Proust. I; ¾ unit. Offered in 1956-1957 and in alternate years. JACOB.

332. **French Novel of the Nineteenth Century, II.** From Balzac to Proust. II; ¾ unit. Offered in 1956-1957 and in alternate years.

333. **La Littérature Contemporaine, I.** In French. Modern poetry from Baudelaire to Valéry. Prose writers from 1900 to 1940. I; ½ unit. Offered in 1957-1958 and in alternate years. JACOB.

334. **La Littérature Contemporaine, II.** II; ½ unit. Offered in 1957-1958 and in alternate years. JACOB.

Russian

Courses in Russian are under the administration of the Department of French. Inquiries concerning courses in Russian should be directed to the head of that department.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. **The Russian Novel of the Nineteenth Century.** Readings in Turgenev and Tolstoi. Historical and literary background of the period. I; ½ unit. Prerequisite: Russian 204 or consent of instructor. SOBOTKA.

322. **The Russian Novel of the Nineteenth Century.** Readings in Tolstoi and Dostoevski. Historical and literary background of the period. II; ½ unit. Prerequisite: Russian 321 or consent of instructor. SOBOTKA.

GENETICS

Students desiring a general training in genetics may take a major or minor in botany or zoology. Those desiring to approach agricultural problems through genetics may take a major or minor in agronomy, horticulture, animal science, or dairy science. For courses in the subject, see the Departments of Agronomy, Animal Science, Bacteriology, Botany, Dairy Science, Horticulture, and Zoology. An interdepartmental genetics seminar is held at frequent intervals. Consult the University's weekly calendar for time and place.

GEOGRAPHY

The Department of Geography offers graduate work leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy. The following fields of geography are available for specialization in graduate study: climatology, economic geography, cartography, land utilization, conservation of resources, regional geography, political geography, historical geography, and educational geography.

Students applying for admission must have a 3.5 grade-point average for that portion of the work which represents the last 50 per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. All candidates for advanced degrees in geography must have an average of at least 4.0 in previous work in geography. Candidates for the Doctor of Philosophy degree have full departmental status if they have completed work essentially equivalent to that required for the master's degree by the department, if their previous graduate record is well above 4.0 and if their qualifications promise superior ability. All others are placed in provisional departmental status and must demonstrate their ability to carry graduate study during their first semester in residence.

Degree of Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose background is largely in physical geography are recommended for the degree of Master of Science; others receive the degree of Master of Arts. The program leading to the master's degree in geography is to add breadth to the student's geographic knowledge and to introduce the student to semi-independent accumulation and use of the geographic materials in seminars, and to independent research and advanced study. Adequate latitude in course requirements is provided to allow the candidate to complete his understanding of the broad aspects of geography (depending on his undergraduate concentration) and to begin to penetrate more deeply into specific phases of geographic content. In this way the master's degree can either be a terminal degree or lead directly into the more intensive study toward the doctorate.

Entering master's candidates are expected to offer at least eighteen hours of undergraduate work in geography in addition to a beginning course; those offering less than this amount must correct this deficiency without graduate credit. At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. In individual cases, additional units of work may be required by the departmental graduate committee. Students must have had, either as an undergraduate or as a graduate, training in climatology, map construction and map reading and interpretation, introductory field work, cultural geography, and regional geography. They must also have proficiency equivalent to that expected of an Illinois undergraduate major in a physical or biological science, in a social science, in statistical method, and in oral and written expression. Geology, botany, soils, or zoology are recommended as physical or biological sciences; economics, history, political science, sociology, or anthropology are recommended in the social sciences. Candidates for the master's degree may use one and one-half units of graduate credit to correct content deficiencies in these divisions of geography and cognate fields.

All candidates for the degree of Master of Science or Master of Arts in Geography must take Geography 477; two of the following graduate seminars: Geography 412, 421, and 497; and at least one-half unit of independent advanced study (Geography 495). Students are advised to enroll in Geography 478 during their master's program, although this course is not a degree requirement.

Degree of Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are electives, two units in education, and two units in electives. Requirements are Geography 493, one unit; Geography 495, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in geography and the other electives must be selected with the approval of the adviser. Two electives must be in geography and the other two in geography, education, or, in exceptional cases, other fields. The grade-point average required for admission is the same as required by the department. Students are not admitted to this program on limited status. The adviser for candidates for this degree is Professor J. H. Garland, 248 Natural History Building.

Degree of Doctor of Philosophy. The doctoral program presupposes an understanding of geographic patterns. This program is, therefore, intended to increase the student's ability to use his knowledge of geography and its allied fields and to provide maximum opportunity for the exercise of independent ability. The doctoral student is encouraged to penetrate deeply into the content, techniques, implications, and significance of specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world.

Candidates for the degree of Doctor of Philosophy in Geography must have taken, either as an undergraduate or as a graduate, all work or the equivalent which is required in the undergraduate major and the master's and doctor's programs of the department. Not more than one and one-half units of credit beyond the eight units required for the Illinois master's degree may be in areas specifically required in the undergraduate major or master's curriculum. Eight of the minimum twenty-four units of graduate credit required for the Doctor of Philosophy degree must be in Geography 493 and are devoted to the completion of an original and independent doctoral thesis. Geography 493 is carried subsequent to the admission of the student to candidacy for the degree.

The work required for a Doctor of Philosophy degree in geography is divided into two phases, first, that of preparing a student for formal admission to candidacy for the degree, and second, the satisfactory completion of the doctor's thesis and the support of the thesis in an examination.

Admission to candidacy for the Doctor of Philosophy degree in geography is recommended after the successful completion of the following requirements:

(1) At least sixteen units of graduate credit, or equivalent, including four units in official minor fields. At least nine of these sixteen units must be in geography, including Geography 477, 421, 497, 478, and 495. Students concentrating in the physical aspects of geography enroll in Geography 412; those concentrating in cultural geography, in Geography 463. Equivalent work taken elsewhere is accepted subject to examination. The department recommends a split minor, consisting of at least two units in each field. One of the minors should be in geology, botany, soils, or zoology, the other in economics, history, political science, or sociology and anthropology. Other minor fields may be accepted upon recommendation of the major adviser.

(2) The required examinations in foreign languages.

(3) A preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College. The examination covers selected divisions of physical, cultural, and regional geography, the techniques and theory of the discipline, and the student's minor fields.

After being admitted to candidacy for the Doctor of Philosophy degree, the student must complete a research thesis which demonstrates his capacity to complete and to support independent and original work in geography. The doctoral thesis normally requires field investigation.

Additional information concerning the requirements of the department may be obtained from the head of the department.

ASSISTANTSHIPS

Teaching assistantships are available in geography. Only students who present records above the minimum requirements for full departmental admission are considered for assistantships. Application for assistantships should be made to Professor J. A. Russell, 249 Natural History Building.

GRADUATE TEACHING FACULTY

Professors: J. A. Russell (Head of Department), A. W. Booth, F. W. Foster, J. H. Garland, J. L. Page.
Associate Professor: R. L. Carmin.
Assistant Professors: J. D. Fellmann, H. G. Roepke.
Instructor: C. S. Alexander.

COURSES FOR GRADUATES

412. Analytical Climatology. A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. II; 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Page.

421. Regional Concepts in Geography. Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. II; ½ unit. Prerequisite: Nine hours of regional geography. Garland.

441. Fundamentals of Bioclimatology. Same as Physiology 441. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological and pathophysiological processes in mammals, and the application of meteorological, climatological, and geographical techniques in physiological studies. I or II; ¾ unit. Prerequisite: Consent of instructor. Page, Sargent.

442. Experimental Bioclimatology. Same as Physiology 442. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physio-

logical adjustments of man to heat, cold, and high altitude. I or II; ½ unit. Prerequisite: Physiology 306 and 307; credit or registration in Geography 441. PAGE, SARGENT.

443. **Advanced Human Bioclimatology.** Same as Physiology 443. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. I or II; ½ unit. Prerequisite: Geography 441. PAGE, SARGENT.

463. **Historical Geography.** Objectives and methods of historical geography. II; 1 unit. FELLMANN.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. II; 1 unit. Prerequisite: Geography 373 or consent of instructor. FOSTER.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. I; 1 unit. FOSTER.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. STAFF.

493. **Research.** I, II; ½ to 4 units. STAFF.

495. **Advanced Studies in Geography.** Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. I, II; ½ to 2 units. Work may be taken in the following fields:

(a) **Anglo-America.** GARLAND.
(b) **Latin America.** CARMIN.
(c) **Europe.** FOSTER, ROEPKE.
(d) **Asia.** BOOTH, RUSSELL.
(e) **U.S.S.R.** FELLMANN.
(f) **Australia and Oceania.** RUSSELL.
(g) **Economic Geography.** ROEPKE, RUSSELL.
(h) **Political Geography.** GARLAND.
(i) **Urban Geography.** CARMIN, FELLMANN.
(j) **Physical Geography.** BOOTH.
(k) **Mathematical Geography.** BOOTH.
(l) **Land Utilization and Conservation.** BOOTH, FOSTER, ROEPKE, RUSSELL.
(m) **Transportation Geography.** BOOTH, FELLMANN, FOSTER.
(n) **Problems of Geographic Study.** STAFF.

497. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. I; ½ unit. FELLMANN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

313. **Climates of the Continents.** A regional treatment of the climates of the world by continents. I; ½ unit. Prerequisite: Geography 101 and 111. PAGE.

314. **Regional Problems in Conservation of Natural Resources.** The distribution, use, and interrelationship of the resources in the various resource management regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. II; ½ unit. Prerequisite: A previous course in conservation, or workshop or field work training in conservation. BOOTH.

332. **Geography of South America.** A regional geography of South America with emphasis on the southern hemisphere of that continent. II; ½ unit. Prerequisite: Eight hours of geography or enrollment in Latin-American studies program. CARMIN.

342. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. I; ½ unit. Prerequisite: Eight hours of geography. FOSTER.

350. **Geography of World Islands Including Australia.** Physical and cultural landscapes of Australia and the major island groups as habitats for man. II; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

351. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. I; ½ unit. Prerequisite: Eight hours of geography. BOOTH.

353. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and transportation. II; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. FELLMANN.

355. **Geography of Central and South Africa.** A regional geography of Africa south of the Sahara. I; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

361. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. I; ½ unit. Prerequisite: One course in geography or enrollment in the College of Agriculture. ROEPKE.

362. **Manufacturing Regions of the World.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. I; ½ unit. Prerequisite: One course in geography, or enrollment in the College of Commerce and Business Administration, or enrollment in the College of Engineering. ROEPKE.

363. **Production of Great World Minerals.** Geographic aspects of the mineral industries. II; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Eight hours of geography. ROEPKE.

365. **Geographic Aspects of Transportation.** Geographic factors influencing transportation by land, sea, and air. II; ½ unit. Prerequisite: Eight hours of geography. BOOTH.

366. **Problems of Industrial Location.** The relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites. II; ½ unit. Prerequisite: Eight hours of geography. Three hours of economic geography for students in the College of Commerce and Business Administration. Engineering and architecture students may register with consent of instructor. RUSSELL.

371. **Introduction to Research.** Introductory training in the techniques and source materials of geographic research. Limited to students whose major is geography and to seniors whose major is in other departments but who have twelve hours of geography. I, II; ½ unit. FELLMANN and others.

372. **Introduction to Research.** Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. II; ½ unit. STAFF.

373. **Map Compilation and Construction.** Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. I, II; 1 unit. Prerequisite: Consent of instructor. FOSTER.

375. **Map Reading and Interpretation.** Evaluation of map components, map reading, map interpretation, map history, and survey of world maps and mapping. I; ½ unit. Prerequisite: Consent of instructor. CARMIN.

376. **Field Geography.** A study of the methods and techniques of field work in geography and the application of the procedures developed to field mapping problems in the Champaign-Urbana area. II; ½ unit. FOSTER.

378. **Descriptive Interpretation of Aerial Photographs.** Reading and interpreting of aerial photographs; their potentialities and limitations as a research tool of geography. II; ½ unit. Prerequisite: Consent of instructor. FOSTER.

383. **Urban Geography.** The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. I; 1 unit. Prerequisite: Eight hours of geography or consent of instructor. FELLMANN.

386. **Political Geography.** World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; western hemisphere nations. I; ½ unit. Prerequisite: Eight hours of geography. Major or graduate students in political science or history may enroll with consent of instructor. GARLAND.

GEOLOGY

Graduate students may take work in geology leading to the degrees of Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, economic geology, geomorphology and glacial geology, mineralogy and petrography, paleontology and stratigraphy, ground-water geology, and sedimentation.

Beginning graduate students admitted to full status in geology must have a grade-point average no lower than 3.75 for that portion of undergraduate work representing the last 50 per cent of the hours completed for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

For graduate work in geology a student must usually have had an undergraduate major in geology, including field training, and the required courses in chemistry, mathematics, and physics. A reading knowledge of French or German is desirable for the beginning graduate student and required for the advanced graduate student. An undergraduate major consists of the following courses or their equivalents: Geology 102, Historical Geology; 131 and 132, Mineralogy; 301, Geomorphology; 311, Structural Geology; 317, Field Geology in the Rocky Mountains, or other acceptable summer field experience; 320, Invertebrate Paleontology; and 321, Stratigraphy. Graduate students in other departments may be admitted to graduate courses in geology if they have had the prerequisites for the course desired, or by special permission.

A candidate for the master's degree in geology must pass a general examination toward the close of the second semester of residence, covering the fields of geology listed in the courses named above and the graduate courses taken.

Graduate students whose undergraduate training has not included all of the "major" courses listed may take these courses if listed as "Courses for Graduates and Advanced Undergraduates." More than the minimum of eight units for a master's degree is required if it is necessary to include an undue number of such 300 courses.

A reasonable choice of minor may be made by students working for the doctor's degree. Ordinarily the minor is chemistry for those specializing in mineralogy and petrography; chemistry, physics, or mining engineering for economic geology; zoology or botany for paleontology; and agronomy (soils) or geography for geomorphology. Other minors may be chosen with departmental approval.

FELLOWSHIPS AND ASSISTANTSHIPS

The Illinois Clay Products Company has established two fellowships for graduate study in the field of clay mineralogy. The stipend is $1,500 each for a year's study plus $500 to cover material and equipment and other expenses related to the research project.

A fellowship for graduate study in clay mineralogy has been established by the Baroid Sales Division of the National Lead Company. The stipend is $1,500 for a year's study plus $900 for research expenses.

A fellowship established by the Shell Fellowship Committee encourages graduate studies in the field of geology leading to a doctor's degree. The stipend is $1,500 for a year's study plus $400 to cover material and equipment and other expenses related to the research project.

There are a number of assistantships available in the Department of Geology. The stipend for half-time assistants is $1,500 and tuition. Occasional appointments of quarter-time assistants are made at a stipend of $750 and tuition. Preference is given to applicants who have had some graduate work and who are working for the Doctor of Philosophy degree but superior students who have just completed the work for the bachelor's degree are also considered. Application should be made to the head of the department, 234 Natural History Building, accompanied by a record of all undergraduate and/or graduate work taken.

GRADUATE TEACHING FACULTY

Professors: G. W. White (Head of Department), C. A. Chapman, R. E. Grim, A. F. Hagner, J. L. Hough, H. W. Scott, P. R. Shaffer, H. R. Wanless.
Associate Professors: D. U. Deere, W. M. Merrill, F. H. T. Rhodes.
Research Associate Professor: G. B. Maxey.
Assistant Professor: D. M. Henderson.

COURSES FOR GRADUATES

401. **Advanced Dynamic Geology.** A study of geologic processes and their effects. II; 1 unit. Offered in 1957-1958 and in alternate years. Wanless.

402. **Advanced Historical Geology.** Principles of interpretation and problems of earth history. II; 1 unit. Offered in 1956-1957 and in alternate years. Wanless.

403. **History of Geology.** II; ½ to 1 unit. Offered in 1956-1957 and in alternate years. White.

409. **Sedimentation.** I; 1 unit. Wanless.

415. **Geology of the Upper Mississippi Valley.** Field study of the geology of Illinois and adjacent states by means of five or six two-day field trips and the preparation of reports. Estimated travel expense, $60. I; 1 unit. WANLESS.

422. **Stratigraphic Geology: Paleozoic.** I; 1 unit. Prerequisite: Geology 321. SCOTT.

423. **Stratigraphic Geology: Mesozoic and Cenozoic.** II; 1 unit. Prerequisite: Geology 321. RHODES.

425. **Micropaleontology: Foraminifera.** Classification of microfossils, foraminifera; stratigraphic correlation. I; 1 unit. Prerequisite: Geology 320 or Zoology 320. SCOTT.

426. **Micropaleontology: Ostracoda.** Classification of microfossils, ostracodes, conodonts, scolecodonts, and other major groups; stratigraphic correlations. II; 1 unit. Prerequisite: Geology 320 or Zoology 320. SCOTT.

435. **Igneous Petrology.** The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory a study is made of selected rock suites, and special methods of petrographical investigation are covered. I; 1 unit. CHAPMAN.

436. **Metamorphic Petrology.** Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied and special methods of investigation are covered. II; 1 unit. CHAPMAN.

437. **Sedimentary Petrology.** II; 1 unit. HOUGH.

440. **Mineragraphy.** Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. I; 1 unit. HAGNER.

443. **Mineral Deposits.** Principles of mineral deposition and genesis of mineral deposits. I; 1 unit. Prerequisite: Geology 311. HAGNER.

444. **Mineral Deposits.** Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. II; 1 unit. Prerequisite: Geology 443. HAGNER.

446. **Petroleum Geology: Principles.** I; 1 unit. Offered in 1957-1958 and in alternate years.

447. **Petroleum Geology: Fields.** A continuation of Geology 446. II; 1 unit. Offered in 1957-1958 and in alternate years.

450. **Geology for Civil Engineers.** Advanced physical geology, with emphasis on the geological aspects of civil engineering. I; 1 unit. Prerequisite: Geology 150 or equivalent. DEERE.

461. **Mineralogy of Clays.** The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. I; 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

462. **Mineralogy of Clays.** The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. II; 1 unit. Prerequisite: Geology 461. GRIM.

491. **Research (Thesis).** Individual work under supervision of members of the staff in their respective fields. I, II; ½ to 4 units.

493. **Advanced Studies in Geology.** I, II; ½ to 2 units. Work may be taken in the following fields:

(a) **Clay Mineralogy.** GRIM.
(b) **Engineering Geology.** DEERE, HOUGH.
(c) **Geomorphology and Glacial Geology.** SHAFFER, WHITE.
(d) **Ground-Water Geology.** MAXEY.
(e) **Micropaleontology.** RHODES, SCOTT.

(f) **Mineral Deposits.** HAGNER.
(g) **Mineralogy and Crystallography.** HENDERSON.
(h) **Paleobotany.** (See Botany 493j.) STEWART.
(i) **Paleontology.** RHODES, SCOTT.
(j) **Pennsylvanian Stratigraphy.** WANLESS.
(k) **Petrography and Petrology.** CHAPMAN.
(l) **Sedimentary Petrology.** HOUGH, WANLESS.
(m) **Stratigraphy.** RHODES, SCOTT.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Geomorphology.** The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. Lectures, laboratory, and field trips. I, II; 1 unit. Prerequisite: Geology 102. WHITE.

311. **Structural Geology.** Rock deformation and its results. Lectures, laboratory, and field trip. I, II; 1 unit. Prerequisite: Geology 102.

315. **Field Methods.** Mapping of an area in southern Illinois or western Kentucky during Easter vacation. Credit is given only on completion of a satisfactory written report. II; ½ unit. Prerequisite: Geology 102. WANLESS.

316. **Field Geology.** Geology of the Baraboo, Wisconsin, region. Field course covering structural, stratigraphic, glacial, and physiographic features. Emphasis is on methods of study and interpretation. A comprehensive report is required to provide training in geological report writing. Credit is given only on completion of a satisfactory written report. S; 1 unit. Prerequisite: Geology 102 or equivalent; consent of instructor. HOUGH.

317. **Field Geology in the Rocky Mountains.** Field course conducted from a locality in the Rocky Mountains. Field training in stratigraphy, structure, and geomorphology. Geologic mapping with plane table, and aerial photographs. Approximate cost, $250 to $305. S; 2 units. Prerequisite: Geology 102; consent of instructor. RHODES.

320. **Invertebrate Paleontology.** Fossil groups in biological sequence. Lectures and laboratory. I, II; 1 unit. Prerequisite: Geology 102. RHODES.

321. **Stratigraphy.** Stratigraphy-fossil faunas, with special reference to invertebrates, correlation, and stratigraphy. I, II; 1 unit. Prerequisite: Geology 320. SCOTT.

325. **Paleobotany.** Same as Botany 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. II; ½ or 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Geology 101 and Botany 100 or Division of General Studies 131 and 132; or consent of instructor. STEWART.

335. **Optical Mineralogy.** Study of the optical properties of minerals and the use of the petrographic microscope. Emphasis is on the identification of minerals by the immersion method. Designed for students in geology, ceramics, chemistry, mining, and agriculture. I; 1 unit. Prerequisite: Geology 132. CHAPMAN.

336. **Petrography.** Study of the constituents, composition, textures, structures, and classification of rocks. In the laboratory, rocks are studied in hand specimen and thin section. Emphasis is on the ordinary methods of petrographical investigation. II; 1 unit. Prerequisite: Geology 335. CHAPMAN.

351. **Geophysical Prospecting.** Same as Mining Engineering 351. Principles of geophysics and their application to mining processes. I; 1 unit. WUERKER.

354. **Mining Geology.** Same as Mining Engineering 354. Structure and occurrence of mineral deposits in relation to prospecting, exploration, development, and exploitation. II; 1 unit. Prerequisite: Geology 101 or 150, 130 or 131, and Mining Engineering 201 or 230; or consent of instructor. WRIGHT.

GERMAN

The Department of German offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Students applying for admission must have a 3.75 grade-point average for that portion of the work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. Students should have completed a four-year course of undergraduate study in German corresponding to the four-year course at this University. They should be familiar with the principal works of the writers of the classical and modern periods of German literature, possess a general knowledge in the history of German letters and civilization, and be able to follow lectures in the German language. Acquaintance with German history, philosophy, and art in their relation to the general European background is highly desirable. A reading knowledge of French is important and is required for advanced graduate work. Some fluency in Latin is also recommended.

Fields of concentration for advanced degrees include German philology and linguistics, older literature, and modern literature. Such studies are greatly facilitated by an excellent library collection which is particularly strong in German literature from the seventeenth to the twentieth century. Special collections include the following items: the German folksong collection (including the Vaticana), the John Meier collection, the Moritz Heyne collection in German philology, the Armin Rattermann collection of German-Americana, the Bab-Feldman collection in modern German drama, and many others.

Candidates for the degree of Master of Arts in the Teaching of German must earn four units in German, two units in education, and two units in electives. Requirements are: German, two or two and one-half units to be chosen from German 301, 302, 311, 312, 315, 320, 331, or 332; one and one-half to two units from German courses open only to graduates; education, two units, including two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives must be selected with the approval of the adviser. The electives may be in German, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the department. Students are not admitted to this program on limited status. The adviser for candidates for this degree is Professor Mimi I. Jehle, 217 Lincoln Hall.

FELLOWSHIPS

Information concerning fellowships may be obtained from the office of the Graduate College. Students desiring graduate assistantships should apply directly to the Department of German, 211 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: J. R. FREY, E. A. PHILIPPSON, D. W. SCHUMANN, H. STEGEMEIER.
Associate Professors: MIMI I. JEHLE, F. J. NOCK.
Assistant Professor: F. G. BANTA (Chairman of Department).

COURSES FOR GRADUATES

400. **Beginning German for Graduate Students.** Introduction to the reading of German texts in the sciences and the humanities. I, II; no graduate credit. NOCK.

401. **Readings in German for Graduate Students.** Designed for graduate students preparing for the German reading requirements for the Ph.D. degree. I, II; no graduate credit. Prerequisite: German 400 or equivalent. NOCK.

411. **Proseminar.** Methods of literary criticism and research. I or II; 1 unit. SCHUMANN.

415. **Middle High German.** I; 1 unit. BANTA.

416. **History of the German Language.** II; 1 unit. PHILIPPSON.

426. **Gothic.** An introduction to Germanic (comparative) linguistics. II; 1 unit. Offered in 1957-1958 and in alternate years. BANTA.

431. **German Literature of the Middle Ages.** German literature from 800 to 1400. I; 1 unit. Offered in 1957-1958 and in alternate years. PHILIPPSON.

432. **German Literature from 1400 to 1700.** Renaissance, Reformation, and Baroque in German literature. Lectures and readings. II; 1 unit. Offered in 1957-1958 and in alternate years. PHILIPPSON.

441. **German Romanticism.** I; 1 unit. Offered in 1957-1958 and in alternate years. SCHUMANN.

442. **Nineteenth-Century German Realism.** II; 1 unit. Offered in 1957-1958 and in alternate years. FREY.

445. **Old High German.** Grammar and interpretation of the oldest literary documents. I or II; 1 unit. Offered in 1956-1957 and in alternate years. PHILIPPSON.

451. **Naturalism, Symbolism, Expressionism.** German literature from the 1880's to the 1920's. I; 1 unit. Offered in 1956-1957 and in alternate years. SCHUMANN.

452. **German Literature from the 1920's to the Present.** II; 1 unit. Offered in 1956-1957 and in alternate years. FREY.

460. **Seminar in German Literature.** Advanced research work in German literature; discussion of problems and papers. I or II; 1 unit. SCHUMANN and others.

491. **Thesis.** I, II; 1 to 4 units. STAFF.

493. **Research in Special Topics.** I, II; 1 to 4 units. STAFF.

495. **Bibliography and Methods in Literary History.** To be taken concurrently with German 411. I or II; ½ unit. FREY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **German Literature to 1700.** I; 1 unit. Prerequisite: Three years of college German or equivalent. FREY.

302. **German Literature since 1700.** II; 1 unit. Prerequisite: Three years of college German or equivalent. FREY.

303. **Conversation, Composition, and Syntax.** Intensive study of advanced problems of grammar, syntax, and style. I; ½ unit. Prerequisite: Three years of college German including German 212, or consent of instructor. JEHLE.

311. **Goethe.** Introduction to Goethe's life and works. I; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Three years of college German. SCHUMANN.

312. **Goethe's Faust.** Intensive study of Goethe's *Faust,* Parts I and II. II; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Three years of college German or equivalent. SCHUMANN.

320. **History of German Civilization.** A selected topical, historical, and pictorial analysis of German culture and civilization. I or II; 1 unit. Prerequisite: Three years of college German or equivalent. STEGEMEIER.

331. **The Age of Lessing.** I; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Three years of college German or equivalent. FREY and others.

332. **Schiller.** II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Three years of college German or equivalent. STEGEMEIER and others.

360. **Introduction to German Phonetics.** I; ½ unit. NOCK.

363. **Introduction to Comparative Literature.** Same as English 363. A comparative study of great books in Greek, Roman, Italian, and Spanish literature. I; ½ unit. ALLEN, LANDIS, VAN HORNE.

364. **Introduction to Comparative Literature.** Same as English 364. A comparative study of great books in French, German, and English literature. II; ½ unit. JACOB, LANDIS, SCHUMANN.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs develops programs of training for the public service, provides in-service training for state and local government employees, holds institutes and conferences for citizens and public officials, and carries out a research program in the field of government and public affairs. The institute serves as a planning and directing agency to correlate the work of existing colleges and departments in the field of public affairs. Royden Dangerfield is the director.

ASSISTANTSHIPS

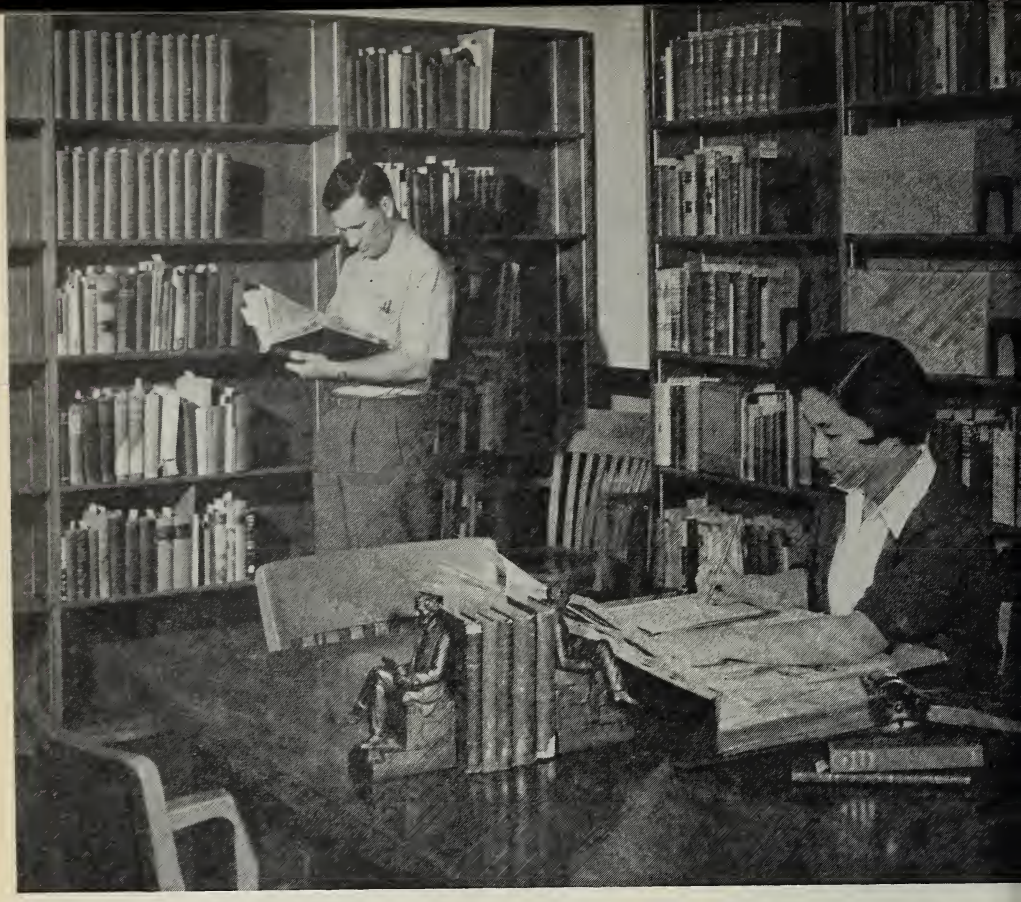
The institute has available a limited number of part-time research assistantships for qualified students in the fields of political science, public administration, law, and economics. Applications should be addressed to the director, 1209 West Illinois Street.

HISTORY

The Department of History offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Professors C. E. Nowell and C. G. Starr form the department's committee in general charge of advising graduate students in history. Graduate work in history presupposes two years of college work in this subject, or sixteen semester hours, which should include courses in European and American history equivalent to History 111, 112, 151, and 152. Linguistic preparation, especially in French and German, is important. For ancient and medieval history some knowledge of Latin is essential. Spanish is useful for certain fields of American and Latin-American history.

Beginning graduate students admitted to full standing in the Department of History must have a grade-point average no lower than 3.5 for that portion of undergraduate work representing the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are admitted on limited status.

Graduate courses in history at the University of Illinois are of three kinds: 1) lecture courses providing information, interpretation, and guidance in general



The Lincoln Room of the University Library. This outstanding collection of material pertaining to the life and time of Abraham Lincoln is available for use by all students at the University of Illinois.

reading; (2) instruction in methodology, historiography, and bibliography (History 495 and 496 are required of all graduate students in history during their first year); (3) seminars for the study of special fields with a view to training in methods of historical criticism and research and in the writing and presentation of historical essays.

The following statement regarding the specific requirements for higher degrees in history conforms to the general requirements of the Graduate College.

Degree of Master of Arts. Shortly after his registration each candidate for this degree is required to take a comprehensive examination based on his undergraduate work in history. Questions are given in the following four fields of history: ancient, medieval and modern European, English, and American. Candidates must answer questions in three of four fields. Each candidate must have a reading knowledge of one foreign language, ordinarily French or German, as demonstrated by an oral examination administered by the department. Each candidate is expected to devote special attention to two of the following fields: ancient history, medieval history of continental Europe, modern history of continental Europe, English history, American history, Latin-American history, and the history of the Far East. Each candidate is also expected to write a master's thesis in one of his fields of specialization. By special permission he may substitute a third field for the thesis requirement. To constitute a field of specialization a minimum of two units of graduate study is ordinarily required.

Graduate study in history may also be pursued in connection with the degrees of Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see page 259).

Degree of Doctor of Philosophy. The candidate who selects history as his major subject should prepare himself for a preliminary examination in five fields, of which four are normally in history and one is in an outside related subject.

The preparation of the candidate should include a minimum of four units in the field of history in which he wishes to specialize and in which his thesis is to be written. This field constitutes his major.

There should be a minimum of three units in a second field known as the first minor, and two units each in three other fields. One of these, outside the department, constitutes the second minor.

The Department of History offers the following fields of specialization and preparation: ancient history, medieval history, continental Europe from 1300 to 1648 (Renaissance and Reformation), continental Europe and its dependencies since 1648, England and its dependencies, the United States, and Latin America. This enumeration of fields is not to be regarded as excluding the possibility of accepting others as may be determined by the department in individual cases.

The second minor field may be selected from the following departments and areas, although other suitable second minors may be arranged through consultation with department advisers:

Political Science. International law and diplomacy, modern government, municipal government, constitutional and administrative law and jurisprudence, political theory.

Economics and Sociology. Economic history, economic theory, public and private finance, social reform, principles of sociology.

Philosophy and Education. History of ancient and medieval philosophy, history of modern philosophy, history of education.

Literature. Some division of the history of literature, which may be either comparative literature of a limited period or the literature of a particular country for a more extended period as may be agreed upon in each case.

Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey,

graduate students in the department are able to obtain useful training in the study of manuscript as well as printed materials.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor (three-unit field) in American literature, and the second minor (two-unit field) in the history of fine arts in the United States.

FELLOWSHIPS AND ASSISTANTSHIPS

The department awards annually to the ranking student in English or medieval history the Laurence M. Larson Memorial Fellowship, which represents the income from a fund of $5,000 set up in the will of Lillian D. Larson in memory of her husband, at one time head of the Department of History.

The department participates with the Department of Political Science in the Kendric C. Babcock Fellowship established under the will of Dean Kendric C. Babcock. For the third year these appointments carry a stipend of $1,500 and postdoctoral grants carry a stipend of $2,400. Nominations for these fellowships are made by the chairmen of the Departments of History and Political Science. Application forms may be obtained from the Graduate College office.

The department has available a number of teaching assistantships which carry the requirement of six hours teaching a week in elementary sections. Before being considered for these appointments, students must have been in attendance in the Graduate College in the Department of History for at least a year, they must have done work of high distinction, and have received the master's degree. There are no formal application forms for applying for these appointments. Correspondence regarding them should be addressed to the chairman of the department, 325 Lincoln Hall. There are also certain research assistantships available. These are subject to the same general regulations as teaching assistantships.

GRADUATE TEACHING FACULTY

Professors: J. W. Swain (Chairman of Department), A. Bestor, E. L. Erickson, C. E. Nowell, K. W. Porter, F. S. Rodkey, F. A. Shannon, C. G. Starr, R. P. Stearns.

Associate Professors: W. J. Bouwsma, C. E. Dawn, J. B. Sirich.

Assistant Professors: J. L. Bates, Natalia M. Belting, Louise B. Dunbar, D. J. Geanakoplos, T. S. Hamerow, Mary L. Shay, R. M. Sutton.

COURSES FOR GRADUATES

401. **Seminar in Medieval History.** East-West relations during the later Middle Ages. I, II; 1 unit.

409. **Seminar in Modern History: The Enlightenment.** I; 1 unit. Stearns.

410. **Seminar in Modern History: The Enlightenment.** Variation of the topics treated in History 409 as student interest and ability (or previous work) necessitate. II; 1 unit. Stearns.

411. **The French Revolution.** A seminar in the history of France and her relations with Europe, 1789 to 1799. I; 1 unit. Sirich.

412. **Napoleon.** A seminar in the history of France and her relations with Europe, 1799 to 1815. II; 1 unit. Sirich.

415. **Seminar in the History of Europe Since 1815.** I; 1 unit. Hamerow.

419. **Seminar in Modern Russian History.** I; 1 unit. Rodkey.

420. **Seminar in Modern Russian History.** II; 1 unit. Rodkey.

431. **Seminar in English History.** I; 1 unit.

432. **Seminar in English History.** II; 1 unit.

452. **Seminar in American History.** Introduction to research. I; 1 unit. PORTER.

453. **Seminar in the Social History of the United States Before 1860.** A seminar in the social and economic history of the United States before 1860. I; 1 unit. SHANNON.

454. **Seminar in the Social History of the United States Since 1860.** A seminar in the social and economic history of the United States after 1860. II; 1 unit. SHANNON.

456. **Seminar in American Diplomatic History.** II; 1 unit. PORTER.

458. **Seminar in American History: The Revolutionary Period.** I, II; 1 unit. DUNBAR.

472. **Seminar in the Intellectual History of the United States.** II; 1 unit. BESTOR.

473. **Graduate Survey of American History to 1865.** I; 1 unit. PORTER.

474. **Graduate Survey of American History Since 1865.** II; 1 unit. PORTER.

475. **Seminar in Latin-American History: The A.B.C. Powers and Mexico.** I; 1 unit. NOWELL.

476. **Seminar in Latin-American History: The Revolutionary Period.** Studies in the history of Latin America during the first half of the nineteenth century; emphasizes research in special topics. II; 1 unit. NOWELL.

482. **Seminar in Ancient History.** I; 1 unit. SWAIN.

491. **Research in Special Topics.** Individual direction in research and guidance in writing theses for advanced degrees. I, II; 1 to 4 units. STAFF.

495. **Historical Method.** Required of all candidates for an advanced degree in history who do not present evidence of similar training elsewhere. I; 1 unit. BESTOR.

496. **History of Historiography.** Introduction to the great historians from early times to the present. II; 1 unit. SWAIN.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

01. **The Middle Ages from 400 to 1100 A.D.** Europe from the fall of Rome to the first crusade. I; ½ to 1 unit. GEANAKOPLOS.

02. **The Middle Ages from 1100 to 1500 A.D.** Europe from the rise of towns to the establishment of national monarchy. II; ½ to 1 unit. GEANAKOPLOS.

03. **History of Byzantine Civilization.** A study of the cultural, religious, and social history of the Eastern Roman Empire from Constantinople's foundation in 330 A.D., to the fall of Byzantium in 1453. Special attention is given to the continuation of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. I; ½ to 1 unit. GEANAKOPLOS.

4. **Medieval Civilization.** Religious and intellectual. II; ½ to 1 unit. GEANAKOPLOS.

5. **The Age of the Renaissance.** I; ½ to 1 unit. BOUWSMA.

6. **The Age of the Protestant and Catholic Reformation, 1500 to 1648.** II; ½ to 1 unit. BOUWSMA.

7. **Classical Islam: The Near East from Mohammed to the Crusades.** I; ½ to 1 unit. DAWN.

8. **The Europeanization of the Near East from 1768 to 1914.** II; ½ to 1 unit. DAWN.

9. **Development of Modern Europe, 1648 to 1789: Absolutism and Colonial Expansion.** I; ½ to 1 unit. SIRICH.

310. **Development of Modern Europe, 1789 to 1815: The French Revolution and Napoleon.** II; ½ to 1 unit. SIRICH.

311. **Europe from 1815 to 1871.** I; ½ to 1 unit. HAMEROW.

312. **Europe from 1871 to 1900.** II; ½ to 1 unit. HAMEROW.

313. **European History from 1900 to 1929.** I; ½ to 1 unit. SHAY.

314. **European History from 1929 to the Present.** II; ½ to 1 unit. SHAY.

322. **History of Spain and Portugal.** A survey of the Iberian Peninsula from the earliest times until the present. I; ½ to 1 unit. NOWELL.

323. **Science, Philosophy, and the Modern European Mind.** Intellectual history of modern Europe from 1543 to 1770. I; ½ to 1 unit. SIRICH, STEARNS.

324. **Science, Idealism, and Materialism.** Intellectual history of modern Europe from 1770 to 1914. II; ½ to 1 unit. SIRICH, STEARNS.

326. **Intellectual and Cultural History of Russia from 1881 to the Present.** II; ½ to 1 unit. RODKEY.

327. **The Russian Revolution.** I; ½ to 1 unit. RODKEY.

328. **History of Soviet Russia from 1917 to the Present.** II; ½ to 1 unit. RODKEY.

333. **History of England from 1377 to 1485.** I; ½ to 1 unit.

334. **The History of England Under the Tudors, 1485 to 1603.** II; ½ to 1 unit.

335. **Foundations of English and American Democratic Institutions from 1603 to 1689.** I; ½ to 1 unit. STEARNS.

336. **Development of English and American Democratic Institutions from 1689 to 1783.** II; ½ to 1 unit. STEARNS.

339. **History of the British Commonwealth in the Nineteenth Century, 1783 to 1900.** I; ½ to 1 unit. ERICKSON.

340. **History of the British Commonwealth in the Twentieth Century, 1901 to the Present.** II; ½ to 1 unit. ERICKSON.

343. **Social and Economic History of England Since the Beginning of the Industrial Revolution.** Social and economic history of England from 1750 to 1848. I; ½ to 1 unit.

344. **Social and Economic History of England Since 1848: The Later Phases of the Industrial Revolution.** Social and economic history of England since 1848. II; ½ to 1 unit.

345. **Constitutional History of England to 1485.** I; ½ to 1 unit.

346. **Constitutional History of England from 1485 to the Present.** II; ½ to 1 unit.

349. **The Age of Discovery.** A survey of the history of discovery centering in the great discovery era of the fifteenth and sixteenth centuries, with a brief survey of earlier discovery and a continuation down to the twentieth century. I; ½ to 1 unit. NOWELL.

352. **Colonial Beginnings of American Life and Institutions.** A study of the seventeenth and eighteenth century colonies. I; ½ to 1 unit. DUNBAR.

354. **The Era of the American Revolution, 1763 to 1789.** II; ½ to 1 unit. DUNBAR.

357. **Social and Economic History of the United States from 1775 to 1860.** The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. I; ½ to 1 unit. SHANNON.

358. **Social and Economic History of the United States Since 1860.** The growth of American economic life and institutions since 1860. II; ½ to 1 unit. SHANNON.

359. **The Civil War and Reconstruction.** Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South

during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. I; ½ to 1 unit. SHANNON.

361. **History of the United States from 1877 to 1917.** I; ½ to 1 unit. BATES.

362. **History of the United States Since 1917.** II; ½ to 1 unit. BATES.

363. **History of the West from 1634 to 1774: French Colonization of North America.** I; ½ unit. BELTING.

364. **History of the West from 1774 to 1830: The American Frontier.** II; ½ unit. BELTING.

365. **History of Illinois from 1809 to the Present.** Evolution of a typical Middle Western commonwealth: political, religious, economical, social, cultural. I or II; ½ unit. SUTTON.

369. **Constitutional Development of the United States to 1865.** I; ½ to 1 unit. BESTOR.

370. **Constitutional Development of the United States Since 1865.** II; ½ to 1 unit. BESTOR.

371. **American Intellectual and Cultural History to 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. I; ½ to 1 unit. BESTOR.

372. **American Intellectual and Cultural History Since 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. II; ½ to 1 unit. BESTOR.

373. **Diplomatic History of the United States to the End of the Nineteenth Century.** I; ½ to 1 unit. PORTER.

374. **Diplomatic History of the United States in the Twentieth Century.** II; ½ to 1 unit. PORTER.

375. **History of Latin America to 1824.** A survey of Latin-American history from the discovery of America until 1824. I; ½ to 1 unit. NOWELL.

376. **Latin America Since 1824.** A history of the Latin-American republics from their independence to the present. II; ½ to 1 unit. NOWELL.

377. **History of the A.B.C. Powers.** History of Argentina, Brazil, and Chile from their origins to the present. I; ½ unit. NOWELL.

378. **History of the Caribbean Area.** A survey of the Caribbean, Mexico, and Central America from the discovery of America to the present. II; ½ unit. NOWELL.

381. **Ancient Greek States.** History of the Greek States from the earliest times to 334 B.C. I; ½ to 1 unit. SWAIN.

382. **Ancient Imperialism.** Alexander and his successors. II; ½ to 1 unit. SWAIN.

383. **The Roman Republic.** History of the Roman Republic to 44 B.C. I; ½ to 1 unit. SWAIN.

384. **Ancient Imperialism.** The Roman Empire. II; ½ to 1 unit. SWAIN.

391. **History of Eastern Asia to 1839.** History of eastern Asia (China, Japan, and Korea) to 1839. I; ½ unit.

392. **History of Eastern Asia Since 1839.** History of eastern Asia (China, Japan, and Korea) since 1839. II; ½ unit.

OME ECONOMICS

The Department of Home Economics offers graduate work leading to the grees of Master of Science or Master of Arts in Home Economics. The major ork may be done in one of five curricula: child development and family re-

lationships, family housing and household management, foods and nutrition, general home economics, or textiles and clothing. The degree of Master of Science in Home Economics Education is granted to those students who take their major work in the field of home economics education.

Students who elect home economics as their major subject for a master's degree should have complied with the undergraduate requirements of the specific field of concentration selected or should have had equivalent training. To be admitted with full status, the grade-point average for that portion of work representing the last 50 per cent of undergraduate work must be at least 3.5, exclusive of required physical education and military training. Students are admitted on limited status. All candidates for a master's degree in home economics must take a minimum of eight units. If a thesis is not to be submitted, a minimum of nine units must be taken. In either case at least four of these units are in home economics. Four units, either in home economics or electives, are courses numbered 400 or above.

Recommended home economics courses, suggested electives, and special requirements for each of the five curricula are as follows:

(1) *Child Development and Family Relationships.* Four units from Home Economics 301, 305, 410, 481, 482, 493, and four units from Anthropology 361; Education 431; Psychology 461; Social Work 451, 452; Sociology 412, 420, 481; or Speech 385.

(2) *Family Housing and Household Management.* Two and one-half units from Home Economics 361, 378, 493, and Agricultural Engineering 393. Additional units to complete the requirement of at least four units in home economics from Home Economics 301, 375, 377, 379, 380, 388, 389, 410, 481, 482. Four units may be selected from Agricultural Economics 341, 477; Economics 313, 400, 401; Education 453; Sociology 476, 477.

(3) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 423, 481, 482, 493. Four units may be selected from Animal Nutrition 401, 402, 405, 407, 408; Bacteriology 308, 309; Chemistry 352, 421, 426, 450, 452; Food Technology 301, 302, 373; or Physiology 306, 307. Chemistry 350 and 354 or 355, or 347 are required.

(4) *General Home Economics.* Four units from prescribed courses in three of the following curricula: (1), (2), (3), or (5). Additional units may be taken in home economics, economics, education, psychology, or sociology.

(5) *Textiles and Clothing.* Three units from Home Economics 380, 386, 388, 389, 395, 482, 493, and one additional unit in home economics. Four units may be taken in related fields and courses: art; Marketing 401, 402, 407, 421; Economics 313, 400, 401, 436, 437; Psychology 441; Sociology 422, 444, 476, 477, 481.

Graduate students who choose home economics as their minor for the degree of Doctor of Philosophy must have adequate preparation in home economics and must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in courses numbered above 400.

Candidates for the degree of Master of Science in Home Economics Education must earn eight units as follows: home economics, two to two and one-half units; education, three and one-half to four units; electives, two units. The requirements are (1) two to two and one-half units of home economics chosen from courses in home management (Home Economics 361, 375, 378, 379), foods and nutrition (Home Economics 320, 322, 323, 326, 330, 331), textiles and clothing (Home Economics 380, 386, 388, 389, 395, 482), child development and family relationships (Home Economics 301, 410, 481, 482); (2) Education 311 and 312, one unit; (3) two of the following courses: Education 301, 302, 303, 304, one unit; (4) Education 453, one unit; (5) Education 456, one unit, or Home Economics 377, one-half unit. The elective courses must be selected with the

approval of the advisers, Professor Janice M. Smith, head of the Department of Home Economics, 109 Bevier Hall, and Professor Letitia Walsh, 102 Gregory Hall.

ASSISTANTSHIPS

Part-time research and teaching assistantships are available in the various areas of home economics. An applicant should have a satisfactory scholastic record and strong professional interest in the area. Applications should be sent to the head of the department, 109 Bevier Hall. To be considered, applications must be received by March 1 prior to the academic year for which an assistantship is desired.

GRADUATE TEACHING FACULTY

Professors: Janice M. Smith (Head of Department), Kathryn V. Burns, D. G. Carter, Nellie L. Perkins, E. Evelyn Smith, Frances O. Van Duyne.

Associate Professors: Harriet T. Barto, Lillian Butler, Margaret R. Goodyear, Pearl Z. Janssen, Florence M. King, Helen E. McCullough, Jane Werden.

Assistant Professors: Beula V. McKey, Catherine M. Sullivan.

COURSES FOR GRADUATES

410. **Problems in Family Living.** Family relationships and their significance to the growth of family members. I or II; 1 unit. Prerequisite: Sociology 220. Perkins.

423. **Problems in Human Nutrition.** Methods of assessing nutritional status of humans. II; ½ to 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Home Economics 324 or equivalent. J. M. Smith.

481. Seminar.
(a) **Child Development and Family Relationships.** Emphasis is on the child. Advanced problems. I; 1 unit. Prerequisite: Undergraduate courses in child development. Perkins.
(b) **Nutrition.** I; ½ unit. J. M. Smith.

482. Seminar.
(a) **Child Development and Family Relationships.** Emphasis is on the family. Advanced problems. II; 1 unit. Prerequisite: Home Economics 410. Perkins.
(b) **Foods.** Study and discussion of recent research. II; ½ unit. Van Duyne.
(c) **Textiles and Clothing.** II; ½ to 1 unit. King.

493. **Research.** Work may be taken in the following subjects: (a) the child and the family, (b) family housing, (c) foods, (d) nutrition, (e) textiles and clothing. I, II; ½ to 3 units. Butler, Carter, King, Perkins, J. M. Smith, Van Duyne, Werden.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

401. **Advanced Problems in Home Guidance of Children.** Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. I, II; ½ to 1 unit. Prerequisite: Home Economics 201 and 202; consent of instructor. Perkins.

305. **Human Heredity.** Heredity in man and its relation to various individual and social problems. Lectures, discussions, and demonstrations. Graduate credit does not count toward a major in genetics. I; ½ unit.

320. **Diet in Disease.** II; ½ unit. Prerequisite: Home Economics 220. BARTO.

322. **Physical Growth and Nutrition.** Lectures, readings, and discussions. I; ½ unit. Prerequisite: Home Economics 220; consent of instructor. J. M. SMITH.

323. **Recent Advances in Foods and Nutrition.** New developments in foods and nutrition through readings, lectures, and discussions. S; ½ unit. Prerequisite: Chemistry 132 or 133; Physiology 103; Home Economics 131 and 220. VAN DUYNE.

324. **Problems in Nutrition.** Discussions and investigations. I or II; ½ to 1 unit. Prerequisite: Home Economics 220; Chemistry 350. MCKEY.

326. **Demonstration Problems and Techniques.** Consideration of the techniques of demonstrations and problems involved. S; ½ unit. Prerequisite: One of the following: Home Economics 232, 262, 272, 301, 379, 380, 386; or consent of instructor. JANSSEN.

330. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. I, II; ½ unit. Prerequisite: Home Economics 131 and 232; Bacteriology 104. JANSSEN.

331. **Problems in Foods.** Individual problems in food preparation and preservation. II; ½ unit. Prerequisite: Home Economics 330. VAN DUYNE.

345. **Institution Management.** Purchase of food supplies and equipment for institutions; grades of food, judging of quality and cost in relation to season, pure food laws and government inspection; the storeroom and its management; equipment and furnishing; floor plans and routing; specifications for equipment; inventory of equipment; visits to stores and markets. I; ½ unit. Prerequisite: Credit or registration in Home Economics 240 and Economics 108; consent of instructor. E. E. SMITH.

350. **Institution Organization and Management.** Organization and menu making for various types of institutions such as residence halls, cafeterias, and hospitals; personnel management and labor problems; records and cost accounting; professional ethics. Opportunity is given for observation and practice in various fields. Field trip required; estimated expense, $50. II; ½ to 1 unit. Prerequisite: Home Economics 220 and 240; consent of instructor. E. E. SMITH.

351. **Special Problems on Group Feeding with Emphasis on the School Lunch.** Planned for teachers in secondary schools and for home advisers and others interested in community feeding problems. Lectures, discussions, and laboratory practice in quantity food management. Emphasis is on the school lunch program as an integral part of the educational system. Special problems in purchasing, floor plans, and equipment are required of graduate students. No credit is given to students who have had Home Economics 350. S; ½ unit. Prerequisite: Home Economics 220, 232, or equivalent; consent of instructor. Food handler's certificate required. E. E. SMITH.

355. **Advanced Quantity Cookery and Catering.** Planned for students in the restaurant management curriculum and for other qualified students. Practice in menu making and aspects of management necessary for special catering functions and meal projects; special lectures and demonstrations emphasizing the artistry of preparation, serving, and merchandising of quality food; supervised practice in various food service units. Field trips and special assignments. II; ½ unit. Prerequisite: Home Economics 350; consent of instructor. E. E. SMITH.

361. **Development and Function of Family Housing.** Same as Agricultural Engineering 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. II; ½ unit. Prerequisite: Home Economics 272 or consent of instructor. CARTER.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment and equipment performance tests. S; ½ unit. Prerequisite: Home Economics 272; six advanced hours (Group III courses) in home economics; consent of instructor. SULLIVAN.

377. **Home Economics Extension.** History and development; types of county organizations; objectives; extension teaching tools; county program determination and evaluation. Field trips. II; ½ to 1 unit. Prerequisite: Consent of instructor. BURNS.

378. **Problems in Home Management.** Individual investigation and reports of specific problems in the field of home management. I; ½ unit. Prerequisite: Home Economics 272; consent of instructor. GOODYEAR, MCCULLOUGH, PERKINS.

379. **Problems in Home Management.** Individual investigation and reports of specific problems in the field of home management. II; ½ unit. Prerequisite: Home Economics 272; consent of instructor. GOODYEAR, MCCULLOUGH, PERKINS.

380. **Textiles.** Textiles from the economic, artistic, physical, and chemical viewpoints. I; ½ unit. Prerequisite: Home Economics 180; Chemistry 132; Economics 108; consent of instructor. KING.

386. **Clothing Design and Construction.** Problems in creating original designs, developing a more thorough understanding of the figure through design adaptation, with emphasis on adaptability to fabric draping or flat pattern construction; investigation of sources of inspiration and relationship to significant trends in design. I, II; 1 unit. Prerequisite: Home Economics 285 and 286. KING.

388. **Problems in Textiles and Clothing.** Investigation and report of specific problems in the field of textiles and clothing. I; ½ unit. Prerequisite: Home Economics 286 or 380; consent of instructor. Each student undertakes an individual problem which in some cases may involve prerequisites in chemistry and physics. KING, WERDEN.

389. **Problems in Textiles and Clothing.** Investigation and report of specific problems in the field of textiles and clothing. II; ½ unit. Prerequisite: Home Economics 286 or 380; consent of instructor. Each student undertakes an individual problem which in some cases may involve prerequisites in chemistry and physics. KING, WERDEN.

395. **Fashion Analysis.** Factors affecting design, production, distribution, promotion, and trends in fashion development; forecasting, methods of measurement and prediction; price levels in relation to fashion cycle and quality in design and workmanship. Field trip; estimated expense, $10. II; ½ unit. Prerequisite: Consent of instructor. KING.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy degrees. Candidates may specialize for either degree in floriculture, plant breeding, pomology, or vegetable crops.

The department requires a grade-point average of 3.75 for that portion of

work which represents the last 50 per cent of the hours completed for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Twenty hours of undergraduate work in horticulture and allied subjects are required of students who choose horticulture as a major, and twelve hours are required of those who select it as a minor. The department waives certain of these requirements for some fields of major study if the student has had an equivalent preparation in the fundamental sciences. It is desirable, when the major field of study is decided upon during the junior or senior year, to select the fundamental science courses accordingly and, if possible, to include in the undergraduate preparation the elementary courses in German or French.

Advanced work in botany, chemistry, entomology, agronomy, genetics, agricultural economics, or plant pathology may be taken advantageously with horticulture to make a well-balanced course of graduate study.

GRADUATE TEACHING FACULTY

Professors: C. J. Birkeland (Head of Department), W. A. Huelsen, R. V. Lott, F. F. Weinard.

Associate Professors: C. Y. Arnold, J. R. Kamp, V. W. Kelley, J. P. McCollum.

Assistant Professors: R. K. Simons, A. E. Thompson, J. S. Titus.

COURSES FOR GRADUATES

447. **Horticulture Seminar.** Discussion of current research and literature pertaining to problems of horticulture and related fields. I, II; ¼ unit. Staff.

491. **Thesis.** Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. I, II; ½ to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor.

493. **Research.** Research on problems in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major or minor. I, II; ½ to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Fruit Diseases.** Same as Plant Pathology 307. Symptomatology; laboratory and field studies of representative diseases; control measures. II; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. Powell.

308. **Vegetable and Canning Crop Diseases.** Same as Plant Pathology 308. Symptomatology; laboratory and field studies of representative diseases; control measures. I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. Linn.

321. **Floricultural Physiology.** Plant hormones, light, temperature, humidity, and gases on growth of ornamental plants; principles of disease and insect control. Lectures, assigned readings, discussion. I; ½ unit. Prerequisite: Botany 130. Weinard.

322. **Plant Nutrition.** Soil conditions in relation to the growth of ornamental plants; soil and plant tissue tests, fertilizers and their use; soilless culture; water supplies and automatic watering. Lectures, assigned readings, discussions. II; ½ unit. Prerequisite: Botany 130; Agronomy 201. Weinard.

333. **Marketing Horticultural Products.** Same as Agricultural Economics 333 and Marketing 333. Products and their utilization; institutions, functions, and agencies; merchandising methods; economic problems involved in horticultural marketing. I; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or five hours of horticulture, or consent of instructor. KELLY.

340. **Statistical Methods for Biological Research.** Same as Agronomy 340, Animal Science 340, and Dairy Science 340. A study of statistical methods as tools for research. When, where, and how to use the methods are stressed along with basic concepts of methodology. I; 1 unit. JACOB.

341. **Designing Experiments for Biological Research.** Same as Agronomy 341, Animal Science 341, and Dairy Science 341. Principles of experimental design are discussed and the available designs of simpler form are studied from the viewpoint of when and how to use them. Specialized applications of experimental designs are taken up. II; 1 unit. Prerequisite: Horticulture 340 or equivalent. JACOB.

345. **Growth and Development of Vegetable Crops.** Factors affecting growth, development, and quality of vegetable crops. Discussions. I; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Botany 130 or consent of instructor. MCCOLLUM.

363. **Advanced Pomology.** The development and performance of fruit plants as influenced by environment and production practices. Discussion, lectures and laboratory. Three-day field trip; transportation furnished. I; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Horticulture 262, Botany 130, and Agronomy 201, or consent of instructor. SIMONS, TITUS.

367. **Morphological, Anatomical, and Physiological Characteristics of Fruits.** The major morphological, anatomical, and physiological characteristics of fruit species and varieties. Lectures, discussion, laboratory, and reference reading. I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Horticulture 262, Botany 130, and Chemistry 132, or consent of instructor. LOTT, SIMONS.

382. **Improvement of Horticultural Crops by Breeding.** Mechanism of hereditary variations and varietal differentiation in horticultural plants as a basis for determining the method of approach to crop improvement problems, with emphasis on asexually propagated crops. II; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Horticulture 110 or equivalent. THOMPSON.

HUMANITIES

The Division of the Humanities is composed of the Departments of Classics, English, French, German, History, Philosophy, Spanish and Italian, and Speech. It sponsors several courses of interdepartmental interest and purpose, serving the Liberal Arts and Sciences requirement in general education. Its teaching faculty consists of the full-time faculties of the departments listed, of the rank of instructor and above. Professor J. H. D. Allen is chairman of the division.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

101. **Introduction to Linguistics.** An introduction to the science of descriptive linguistics. I; 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

302. Comparative Linguistics. An introduction to the historical aspects of lan guage. II; 1 unit. Prerequisite: Fulfillment of the foreign language require ment in the College of Liberal Arts and Sciences or equivalent. BANTA.

JOURNALISM AND COMMUNICATIONS

Two advanced degrees are offered: the Master of Science degree with major in news-editorial, advertising, or radio and television; and the Master o Television degree.

For the program leading to the Doctor of Philosophy degree in Mass Com munications, see page 194.

Degree of Master of Science in Journalism. Admission to the Master c Science degree program in journalism is based on the following: (1) completio of the requirements for a bachelor's degree in an institution of recognized stand ing, preferably with a major (normally twenty semester credit hours) in journal ism, English, or the social sciences; (2) a grade-point average of at least 3. for that portion of the work which represents the last 50 per cent of the hou completed to secure the bachelor's degree, exclusive of required physical educatio and military training.

Requirements for the degree of Master of Science include the following:

(1) A major in editorial, advertising, or radio-television consisting of fo units, or three units in journalism and communications and one additional un approved by the Graduate College, including:

(a) For editorial majors, at least two units from Journalism 471, 473, an 474. Candidates in the editorial field who do not present an acceptable unde graduate major in journalism are required to complete Journalism 311, 321, an 323 for the master's degree.

(b) For advertising majors, at least two units from Journalism 471, 481, an 482. Candidates in the advertising field who do not present an acceptable unde graduate major in journalism are required to complete Journalism 382, 383, an 384 for the master's degree.

(c) For radio-television majors, at least one unit from Journalism 462 471. Candidates in the radio-television field who do not present an acceptab undergraduate major in journalism are required to complete Journalism 252, 36 and 386 for the master's degree.

(2) A minor of at least two units in a subject other than journalism.

(a) For editorial majors, the recommended fields are economics, Englis history, philosophy, political science, psychology, and sociology.

(b) For advertising students, the recommended fields are marketing, ec nomics, home economics, psychology, and sociology.

(c) For radio-television students, the recommended fields are psycholog economics, sociology, political science, and speech.

(3) A thesis, which may be for one or two units.

(4) A minimum of three units in courses (including thesis) at the 4 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

Degree of Master of Television. The purpose of this program is to provi professional training for persons who expect to go into non-engineering areas television.

For admission to this program, a candidate must have a bachelor's degr from an accredited institution, must meet the minimum requirements for admi sion to the Graduate College, and ordinarily must have majored in radio, tel vision, theater arts, journalism, or some other area related to television. Appl cants for admission are selected by an entrance committee. Candidates who c not present acceptable undergraduate training are required to complete the f

lowing undergraduate courses: Journalism 252, Television Laboratory, and Journalism 261, Principles of Radio and Television Broadcasting. Under exceptional circumstances, such as professional experience in television broadcasting, this requirement may be waived.

Requirements for the degree of Master of Television include a total of eight units of credit, with a minimum of six units selected from courses in the television sequence. The following courses must be included among the six units of television: (1) Journalism 462, Seminar in Radio and Television, one unit; (2) Journalism 450, Special Problems in Television, two units; (3) Journalism 368, Radio and Television Regulation, one-half unit, and Journalism 386, Radio and Television Advertising, one-half unit, if these courses or their equivalents have not been completed on the undergraduate level.

Students are expected to plan their programs around a special interest area. These areas of special interest include television production and direction, television writing, television news, television advertising, cinematography for television, television art, and television scenic design.

The program differs from the regular Master of Science program in these respects: it does not require a thesis, but instead requires study in special problems of television; it does not require a minor but permits concentration in the fifth year in the radio and television field.

FELLOWSHIPS AND ASSISTANTSHIPS

Graduate students in journalism may apply for graduate fellowships. The stipend is $1,200 and tuition. Appointments are made by the Graduate College. No work requirements are attached to these awards. Selection is based on character, scholarship, and promise of success.

The International Circulation Managers' Association awards annually two fellowships of $750 each to graduates in journalism who intend to continue their education. Information concerning the fellowships may be obtained from H. Phelps Gates, *Christian Science Monitor*, Boston, head of the association committee which makes the awards.

Graduate assistantships are offered to outstanding college graduates with newspaper, radio, television, or advertising experience. These awards carry a stipend of $750 to $1,500 an academic year, plus tuition. The work requirement is ten to twenty clock hours a week.

Holders of assistantships can complete the requirements for a master's degree in three semesters or in two semesters and one summer session. Assistants are expected to teach laboratory classes in basic courses of the field of their experience or handle paper grading in other courses as directed.

GRADUATE TEACHING FACULTY

Professors: F. S. Siebert (Director of the School of Journalism and Communications), R. R. Barlow, L. W. McClure, L. W. Murphy, C. H. Sandage.

Associate Professors: D. E. Brown, T. B. Peterson, F. E. Schooley, N. Wedding.

Assistant Professors: H. V. Cordier, J. J. Mullen, J. C. Sutton, P. H. Tannenbaum.

Instructors: M. D. Froke, G. G. Hanson, R. L. Rider, H. W. Sargent.

Lecturer: H. J. Skornia.

COURSES FOR GRADUATES

550. Special Problems in Television. Project work for advanced students in specific areas of television including news, advertising, directing, writing,

etc. I, II; 1 to 2 units. Students may reregister for this course up to a total of four units. Prerequisite: A television course in the area of specialization; consent of instructor. RIDER.

451. **Television Program Management and Production.** Problems in originating, planning, and producing television programs. II; 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor.

462. **Seminar in Radio and Television.** Same as Mass Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. II; 1 unit. SKORNIA.

471. **Theory of Communications.** Same as Mass Communications 471. Nature of the communication process; development of communication patterns and institutions; principles governing the control and support of mass communications; content and audience study; effects of communication; and relation of mass communications to public opinion and group action. I; 1 unit. TANNENBAUM.

473. **History and Theory of Freedom of the Press.** Same as Mass Communications 473. Development of the Anglo-American press system; philosophical bases of competing press systems. I; 1 unit. PETERSON.

474. **Government and Mass Communications.** Same as Mass Communications 474. Current legal, constitutional, and administrative problems of media of mass communications; contemporary issues resulting from the restrictive, regulatory, and supplementary activities of government in the field of mass communications. II; 1 unit. SIEBERT.

481. **Advanced Advertising Principles.** Same as Marketing 481 and Mass Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Marketing 482 and Mass Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both non-quantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

490. **Research in Special Topics.** Same as Mass Communications 490. I, II; ½ to 1 unit. Students may reregister for a total of 2 units. Prerequisite: Consent of instructor. STAFF.

492. **Thesis.** I, II; 1 to 2 units. SANDAGE, SIEBERT, SKORNIA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **High School Journalism.** Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. II; ½ unit. Prerequisite: Education 211 or consent of instructor. BROWN.

309. **Public Relations.** Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. I; ½ unit. MURPHY.

310. **Press Systems of the World.** Press of England, France, Germany, Italy, Russia, Latin America, China, and Japan; international organization of the press. II; ½ unit. BARLOW.

311. **Newspaper Law.** Freedom of the press; the right to gather, publish, and comment on the news. I, II; ½ unit. SIEBERT.

320. **Editorial Studies and Writing.** Writing of editorials and preparation of editorial judgments. Policies for editorials and for the editorial page. I; ½ unit. Prerequisite: Journalism 212. BARLOW.

321. **Copyreading.** Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and makeup and design of newspaper pages. I, II; 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212. SUTTON.

323. **Advanced Reporting.** Advanced types of news investigation and treatment. I, II; ½ unit. Prerequisite: Journalism 211 and 212 or equivalent.

327. **Special Topics in Twentieth Century Journalism.** Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. II; ½ unit. Prerequisite: One course in college history; consent of instructor. MURPHY.

328. **Industrial Publications.** Problems and techniques of editing house organs. I; ½ unit. Prerequisite: Journalism 211 or 227. PETERSON.

351. **Graphic Production Processes.** Detailed study of the preparation of copy and illustrative material for the mass production of news, features, and advertising; comparison of quality and costs of production processes; consideration of personnel, equipment, and raw materials entering into graphic production. I, II; ½ unit. Prerequisite: Journalism 204. HANSON.

353. **Television Script Writing.** General principles of writing for television, including all non-dramatic and dramatic forms. I, II; ½ unit. Prerequisite: Journalism 252; consent of instructor. CORDIER.

354. **Television Directing.** The theory and techniques of directing the television program. Experience in directing laboratory productions. II; ½ unit. Prerequisite: Journalism 252; consent of instructor. RIDER.

355. **Television News.** News coverage, script preparation, use of visual materials and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. II; ½ unit. Prerequisite: Consent of instructor. FROKE.

356. **Cinematography for Television.** The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. II; ½ unit. Prerequisite: Consent of instructor. RIDER.

362. **Radio and Television Station Management.** A study of the organization and administration of the radio staff and station; public relations, personnel management, and station operation; analysis of station and agency relationships and radio sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. II; ½ unit. Prerequisite: Journalism 261. SCHOOLEY.

365. **Radio News.** News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. I, II; ½ unit. Prerequisite: Journalism 211. BROWN.

366. **Advanced Radio and Television Practices, I.** Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. I; ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. **Advanced Radio and Television Practices, II.** Continuation of Journalism 366. II; ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. **Radio and Television Regulation.** Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communi-

cations Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. II; ½ unit. SIEBERT.

382. **Advertising Copy and Layout.** Same as Marketing 382. Theory and practice of advertising copy writing and layout for newspaper, magazine, and direct mail; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. I, II; 1 unit. Prerequisite: Journalism 204 and 281. SARGENT.

383. **Advertising Media.** Same as Marketing 383. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. I, II; ½ unit. Prerequisite: Journalism 281. MULLEN.

384. **Advertising Campaigns.** Same as Marketing 384. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements—copy and layout. Graduate students do not receive credit for both Journalism 384 and 387. I, II; ½ unit. Prerequisite: Journalism 282 or 382, and 383. WEDDING.

385. **Advertising Promotion and Sales.** Same as Marketing 385. Sales problems, advertising promotion, advertising research, market research. I, II; ½ unit. Prerequisite: Journalism 281. MCCLURE.

386. **Radio and Television Advertising.** Same as Marketing 386. Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. I, II; ½ unit. Prerequisite: Journalism 281. SANDAGE.

387. **Advertising Policies and Problems.** Same as Marketing 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Consideration is given to management problems at both the national and retail levels. Graduate students do not receive credit for both Journalism 384 and 387. I, II; ½ to 1 unit. Prerequisite: Journalism 281. WEDDING.

390. **Economics of Communications, I.** Same as Economics 390 and Mass Communications 390. Economic problems associated with the public means of communication: telephone, telegraph, the postal service, the various forms of radio broadcasting including FM, television, and facsimile, and the use of radio for the safety and efficiency of transportation, protective services, etc. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

391. **Economics of Communications, II.** Same as Economics 391 and Mass Communications 391. Economic problems associated with the following means of communications: motion pictures, newspapers, magazines, and books. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

392. **Research Methods for Press, Radio, and Television.** Same as Mass Communications 392. An introduction to relevant research methods and practices for mass media personnel who need to use research as a tool of management and policy, order research, and interpret research. Lectures, readings, and laboratory practice. II; ½ unit. TANNENBAUM.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a degree of Master of Arts in Labor and Industrial Relations through an integrated curriculum of the social sciences which apply to this field. Institute courses are also available

to the student working for the Master of Arts, Master of Science, or Doctor of Philosophy degrees in other departments of the University.

Students applying for admission must have a grade-point average of at least 3.5 for that portion of the work which represents the last 50 per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

The institute's study program is based on the student's need for an understanding of the broad social and economic factors shaping our industrial society, some degree of specialization, and opportunities for practical experience in the field.

Students are admitted to the institute on approval of the director and upon presenting a minimum of twenty-one hours in the social sciences, of which six should be in economics other than statistics. Other social sciences include history, philosophy, political science, psychology, and sociology. At least three hours credit in statistics and three hours credit in labor economics or labor problems are to be included in the total of twenty-one hours.

Students who can not meet these special course prerequisites may register for graduate work but must remove any deficiency during the first year of residence by taking the prescribed courses without graduate credit, unless exempted for reasons satisfactory to the adviser in charge.

A candidate for the Master of Arts degree in Labor and Industrial Relations must complete eight units of graduate credit including one unit in the research seminar in labor and industrial relations (Labor and Industrial Relations 493), five units to be selected from appropriate courses, and two units devoted to the writing of a thesis.

With the approval of the institute, courses to meet the five-unit requirement may also be selected from those offered in other departments of the University.

In addition to the eight units described above, the student must have a work experience for a minimum of three months. The student must show through oral and written examinations that he has an understanding of the practical problems involved in employer-employee relationships. It is also important that he understand the effects of various solutions of these problems on the employer, the employee, the industry, and the community outside the plant.

Although previous work experience may be offered by means of a detailed petition, it is advisable for the student to have one semester of graduate study before his work experience in order to prepare himself more adequately for his oral and written examinations. Work experience examinations must be completed at least one month in advance of the thesis examination.

Full details of the institute program are given in the bulletin "Graduate Study in Labor and Industrial Relations" which may be obtained by writing to the Institute of Labor and Industrial Relations, 704 South Sixth Street.

ASSISTANTSHIPS

The institute offers graduate assistantships to students whose undergraduate records and work experience are superior. These awards pay not less than $1,500 (plus tuition) for the academic year. The work requirement is twenty hours a week. Institute research projects, information service, and extension programs provide valuable practical experience to supplement classroom instruction. For full details see the institute bulletin "Graduate Study in Industrial Relations." Application forms may be secured by writing directly to the institute, 704 South Sixth Street.

GRADUATE TEACHING FACULTY

Professors: R. W. Fleming (Director of the Institute of Labor and Industrial Relations), W. E. Chalmers, M. Derber, P. L. Garman, E. B. McNatt, W. H. McPherson, J. B. Parrish, R. Stagner.

Associate Professors: Margaret K. Chandler, M. Edelman, H. Rosen, R. C. Wilcock.
Assistant Professors: B. Karsh, S. B. Levine.

COURSES FOR GRADUATES

401. **Crucial Issues in Industrial Relations.** Identification of the most crucial problems facing labor, management, and the public in pursuit of common, conflicting, and interrelated objectives in industrial relations. Based on an integrated approach combining the concepts of economics, psychology, sociology, and political science as applicable to these problems. I, II; 1 unit. Prerequisite: Registration in the Institute of Labor and Industrial Relations curriculum or consent of instructor. Chalmers, Levine.

418. **Seminar in Industrial Sociology.** Same as Sociology 418. Individual research in sociological interpretation of industrial organization; the orientation and motivation of the individual in industry and commerce; labor-management relations as group adjustments; the interrelations of industry and the community. I; 1 unit. Prerequisite: Six hours of sociology including Sociology 318, or consent of instructor. Chandler.

420. **Formation of Public Policy.** Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. I or II; 1 unit. Hagan.

437. **Psychogenics of Industrial Conflict.** Same as Psychology 437. Offers an opportunity for advanced study, through readings in current literature, lectures, field projects, and visiting speakers, of the psychological origins of industrial conflict. Theoretical analysis of the perceptions, emotions, motives, and frames of reference of managerial executives, workers, and union officials is supplemented by visits to industrial enterprises and union headquarters. Each student is required to do an intensive library and field study of some specific problem in labor-management relations. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 357 or equivalent. Rosen, Stagner.

440. **Labor Economics.** Same as Economics 440. A critical economic analysis of contemporary English and American wage theory, employment and unemployment, and collective bargaining, with emphasis on public policy. I; 1 unit. Prerequisite: Six hours of economics. McNatt.

441. **Labor Economics.** Same as Economics 441. A critical economic analysis of contemporary English and American wage theory, employment and unemployment, and collective bargaining, with emphasis on public policy. II; 1 unit. Prerequisite: Six hours of economics. McNatt.

442. **Problems and Practices in Collective Bargaining.** Same as Economics 442. Seminar in the methods and techniques of collective bargaining in the negotiation of the labor contract; nature and significance of labor agreements; union, management, and public interests in major contract provisions. I; 1 unit. Prerequisite: Consent of instructor. McPherson.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Economics 443. Seminar in the techniques of labor contract administration; comparative study of grievance procedure operation; analysis of conciliation, fact-finding, and arbitration procedures, including case studies of arbitration awards. II; 1 unit. Prerequisite: Consent of instructor. McPherson.

444. **The Labor Market.** Same as Economics 444. Basic labor force concepts and measurement; economic theory of market operation and contemporary re-

search; long and short run changes in labor force size, composition, mobility, and participation rates; wartime problems of mobilizing labor resources; international aspects, industrial and military, of differential population and labor force growth; public policy and market operation. I; 1 unit. Prerequisite: Six hours of economics. PARRISH.

445. **The Labor Market.** Same as Economics 445. Concepts, sources of materials, methods of analysis, nature of labor supply; nature of labor demand and recruitment; determinants of interplant occupational mobility with emphasis on the wage structure and the role of wages in allocation of labor supply; adjustment to technological change; problems of the older worker; development of market policy by unions and management; development of public policy including employment service and anti-discrimination programs. II; 1 unit. Prerequisite: Six hours of economics. PARRISH.

446. **Trade Unions and the Economy.** Same as Economics 446. The economic significance of trade unionism: the role of unions as economic policymaking institutions; basic economic criteria in union-management negotiations; union policies and changing technology; unions and social security issues; effect of trade union policies and practices on the functioning of a competitive system. I; 1 unit. Prerequisite: Six hours of economics. PARRISH.

447. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure and government of the modern American trade union movement with particular reference to the relation between organization and function. Problems relating to the function and execution of economic policies, the maintenance of unity and discipline, the adjustment of jurisdictional conflicts, and the observance of agreements are examined and appraised. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. CHALMERS, GARMAN.

448. **Problems of Personnel Management.** Same as Management 448. An examination of the organization and administration of the personnel function in management. Deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. I; 1 unit. Prerequisite: Economics 248 or equivalent; consent of instructor. PLANTY.

449. **Problems of Personnel Management.** Same as Management 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. II; 1 unit. Prerequisite: Economics 248, Labor and Industrial Relations 448, or equivalent. PLANTY.

450. **Case Problems in Industrial Relations.** A seminar in the analysis of case problems drawn from industry, unions, and government. The cases involve actual and specific problem situations facing industrial relations administrators. Proposed solutions are developed through both group and individual analysis, and both oral and written presentations of analyses and recommendations are used. I, II; 1 unit. Prerequisite: Labor and Industrial Relations 493 and two other graduate courses in labor and industrial relations; consent of instructor. FLEMING, WILCOCK.

491. **Thesis Seminar.** For all students writing theses in labor and industrial relations. I, II; ½ to 2 units. STAFF.

493. **Research Seminar in Labor and Industrial Relations.** Systematic analysis of theories and procedures of the various social and physical sciences bearing

on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, LEVINE.

494. **Labor Relations in Modern Society.** An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. I or II; 1 unit. Prerequisite: Consent of instructor. DERBER.

495. **On-the-Job Research in Industrial Relations.** The analysis of the industrial relations characteristics of a specific work situation. The analysis is to be undertaken in three stages: (1) the tentative selection of a subject-matter problem area to be investigated, followed by a survey of the literature summarizing findings in this problem area; (2) the collection of field data, largely by working for a minimum of three months as a participant in an industrial establishment; (3) the preparation and submission of an analytical report interpreting the work situation in relation to published findings about the problem area. I, II; 1 unit. Prerequisite: Credit or registration in Labor and Industrial Relations 493, and in two other graduate courses in labor and industrial relations. These must be completed before credit is given for Labor and Industrial Relations 495.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

312. **Human Relations in Business.** Same as Management 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. I, II; ½ unit. Prerequisite: Management 101 or equivalent. DAUTEN, PLANTY.

318. **Human Relations in Industry.** Same as Sociology 318. Sociology of industry and problems of personal adjustment; the emergence of modern industrial and labor organizations and their impact upon community life. I, II; ½ unit. Prerequisite: Psychology 100; Sociology 100 or 104 and 105, or Division of General Studies 151 and 152, or consent of instructor. KARSH.

342. **Economics of Social Security.** Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MCNATT.

343. **Collective Bargaining.** Same as Economics 343. Emergence of collective bargaining in American industry; national labor policy and bargaining; impact of bargaining on union and management structures and policies; bargaining processes and techniques; the labor agreement including contract provisions, grievance procedures, arbitration; economic consequences of bargaining; case studies of union-management relationships and problems. II; ½ to 1 unit. Prerequisite: Economics 240. PARRISH.

344. **The Law and Labor.** Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; Economics 240. MCNATT.

346. **Foreign Labor Movements.** Same as Economics 346. Analysis of the history, organization, economic policies, political programs, and domestic, international, and contemporary influence of the labor movements of Great Britain,

Sweden, Germany, France, Latin America, and Russia. I; ½ to 1 unit. Prerequisite: Economics 240. CHALMERS.

347. **Labor Law.** Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; collective bargaining and labor contracts; wages and hours legislation; unemployment compensation. I or II; 1 unit. SULLIVAN.

357. **Psychology of Industrial Conflict.** Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. Motives, emotions, attitudes, and ways of perceiving situations are considered in relation to the actions of industrial executives, factory workers, and union leaders. Results of factory observation, public opinion polls, laboratory experimentation, and psychoanalysis are integrated to provide a systematic interpretation of the problem, and to evaluate proposed actions toward a solution. I or II; ½ to 1 unit. Prerequisite: Psychology 100 or equivalent; Psychology 245, Economics 240, or Sociology 318. ROSEN, STAGNER.

365. **Theory and Administration of Federal Labor Law.** Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. I or II; ½ to 1 unit. EDELMAN.

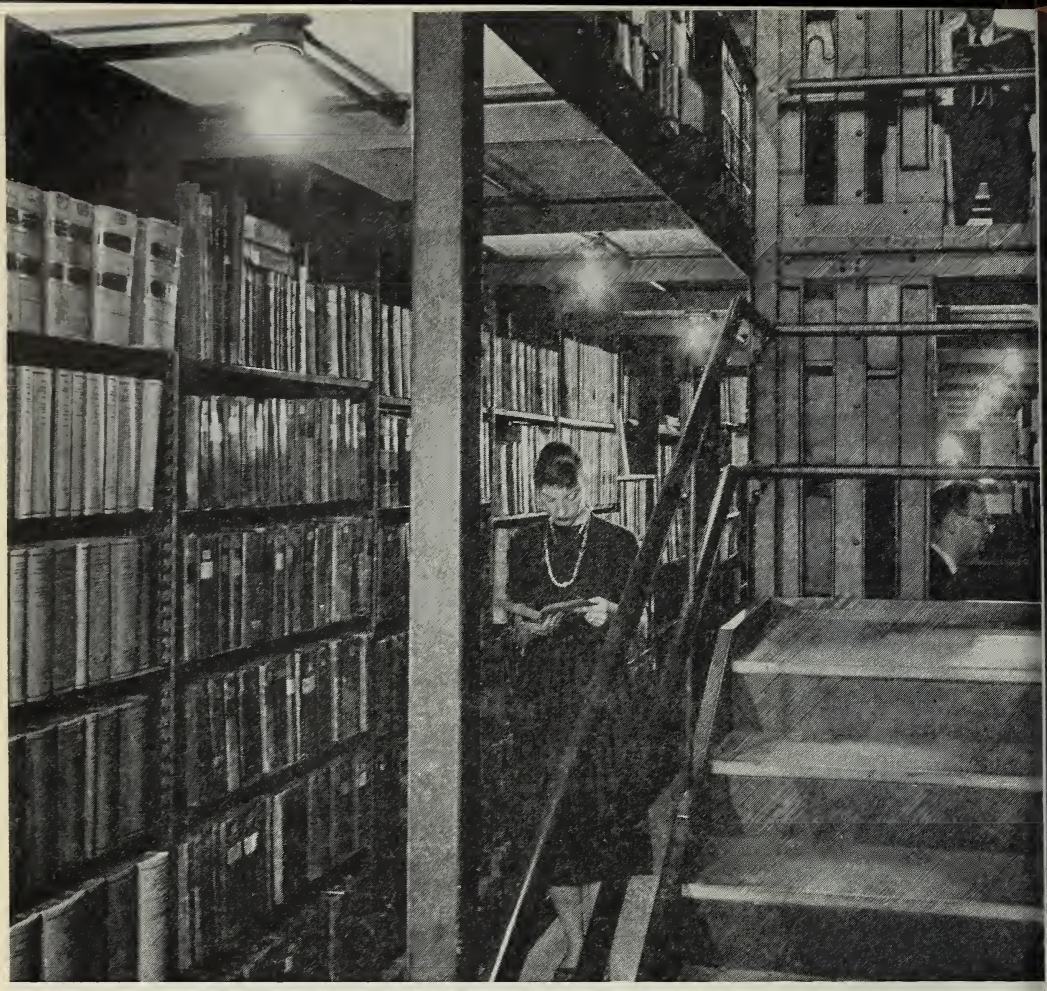
368. **Public Personnel Administration.** Same as Political Science 368. An analysis of personnel management in government. Recruitment and selection, job and salary classification, work standards, training, and the role of labor and professional organizations in the public services are considered in the light of current theory and practice. I or II; ½ to 1 unit. PAGE.

LAW

The College of Law offers a program of graduate work leading to the degree of Master of Laws (LL.M.) and to the degree of Doctor of the Science of Law (J.S.D.).

For admission, an applicant must have received a first degree in law from the University of Illinois or from a law school approved by the University, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws degree unless he has a grade average of 3.5 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of the Science of Law is normally required to have a grade average of 4.0 in all law work previously undertaken, and also to present evidence that he has the capacity to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Bachelor of Laws degree or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for either degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the LL.M. must secure an average of 3.5 in his graduate law courses; the candidate for the J.S.D., an average of 4.0.



Books are a primary instrument of research, particularly in the humanities and the social sciences. The University of Illinois has a distinguished library available for its students and staff.

Details of the programs may be obtained from the Dean of the College of Law, 209 Law Building.

FELLOWSHIPS

Fellowships for graduate study are available for qualified applicants. The number and amount of these awards are fixed by the committee on graduate study with regard to the experience and needs of the applicant.

GRADUATE TEACHING FACULTY

Professors: A. J. Harno (Dean of College of Law), K. S. Carlston, E. W. Cleary, R. G. Cohn, J. E. Cribbet, G. W. Goble, H. W. Holt, M. I. Schnebly, R. N. Sullivan, W. L. Summers, J. N. Young.
Associate Professors: C. H. Bowman, W. D. Warren.

LIBRARY SCIENCE

The purpose of the Library School is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree and the doctor's degree in library science.

Following suitable undergraduate preparation in general educational subjects as well as professional library courses, a fifth year of advanced professional study, combined with some advanced non-library studies, leads to the degree of Master of Science in Library Science. This degree represents the minimum academic preparation for professional librarianship.

Experienced librarians of marked professional capacity and promise may pursue a program of advanced study and research leading to the degree of Doctor of Philosophy in Library Science. The normal minimum period of study is two years beyond the master's degree.

Students holding bachelor's degrees from any accredited institution but without previous course work in library science are eligible for admission to the master's program upon completion of the pre-graduate professional core. Normally, this may be accomplished in any regular summer session.

Students holding bachelor's degrees from any accredited four-year or five-year library school may be admitted directly to the master's program without further course work.

Degree of Master of Science. Applicants for admission to the Library School must first be admitted to the Graduate College. Ordinarily applications are not considered from persons over thirty-five years of age unless they have been actively employed within recent years in library work or in teaching.

Admission to the Graduate College is based upon the following requirements:

(1) Graduation from an institution whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois.

(2) A grade-point average of at least 3.5, or half-way between B and C, for the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training.

In addition, applicants to the Library School must meet the following requirements:

(1) A reading knowledge of at least one modern foreign language. This requirement may be met either by completing at least one academic year of study at the college level or by passing a proficiency examination administered by the Library School.

(2) Preprofessional study appropriate for advanced study in library science.

(3) Completion of a prescribed program of undergraduate library science courses. This requirement may be met by one of the following:

(a) Completion of at least eighteen semester hours of library science with a grade average of at least 3.75 from an institution approved by the University of Illinois Library School.

(b) Completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, from the University of Illinois Library School with a grade average of at least 3.75. Exemption from one or more of these courses may be secured by a satisfactory score on proficiency examinations which are offered on the day preceding the opening of registration each semester and summer session.

There is a special offering of these four courses each eight-week summer session, enabling beginning students to complete the entire preparatory sequence prior to entry into the regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program and students are urged to plan accordingly. While the preparatory courses may be taken during the regular academic year, students with no previous training in library science who enter in the fall or spring need one additional semester of residence to complete the requirements.

(4) Evidence of ability to pursue graduate work in library science.

Each student's program of study is planned to suit his particular needs and purposes. This is done in consultation with an adviser at the time of original registration and thereafter. While there are no prescribed courses, there is a basic graduate library science core of courses which constitutes the nucleus of most students' study programs. This basic core includes courses in library administration, cataloging and classification, communications, and library materials; specifically Library Science 405, 407, 409, and either 411 or 412, plus at least two but no more than two and one-half units of credit drawn from the four literature courses, Library Science 301, 302, 303, and 304. Departures from this basic core may be made upon recommendation of a student's adviser and with the approval of the associate director. In addition, the general field work program is required of students lacking equivalent library experience.

Depending upon his previous training, a student may do a portion of his study outside the Library School. Students thinking of careers in special libraries may find useful the varied courses available through cooperation with other departments of the University.

No thesis is required, but to insure that every candidate for a master's degree has satisfactorily demonstrated his ability to assemble, organize, and present information and ideas in acceptable written form, each student is required to prepare a formal term paper in one of his library science courses, this paper to be designated as the master's project.

At least two semesters in residence, or the equivalent, are required to attain the master's degree, apart from the preparatory courses. In this period, nine units of graduate study are to be completed. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five.

Advanced Master's Program. Students possessing a fifth-year bachelor's degree from an accredited library school are enrolled in the advanced master's program. Eight instead of nine units of graduate credit are then required for the Master of Science degree. A thesis is optional, and may, under certain circumstances and with specific approval of the Graduate College, be written *in absentia.* The course of study for an advanced student is, with the assistance of the student's adviser, individually planned. There are no specified or required library science courses and as many as four of the eight required units may be earned in courses offered in other departments of the University.

Correspondence regarding admission should be addressed to the Associate Director of the Library School, from whom the detailed Library School announcement and the necessary application blanks can be secured. All applications, transcripts, and other necessary papers should be filed as early as possible and not later than four weeks before the date of registration. No student should complete his plans for attending the Library School until he has been notified of his admission.

Degree of Doctor of Philosophy. A student desiring to pursue a program of study and research leading to the degree of Doctor of Philosophy in Library Science must meet the customary admission requirements of the Graduate College. In addition, he must meet the following requirements of the Library School:

(1) A master's degree in library science from an accredited library school or a bachelor's degree in library science from an accredited library school plus a master's degree in a subject field.

(2) A substantial period of acceptable professional library experience.

(3) Evidence of capacity for research and productive scholarship.

The normal minimum period of study required for the degree of Doctor of Philosophy is two years beyond the master's degree, during which the student is required to devote all his working time to studies. All three years must be spent in resident graduate study at some accredited educational institution, and either the first two or the last one of the three must be spent at the University of Illinois. The degree is conferred, however, not for residence during a certain period but for scholarly attainments and power of investigation as proved by a thesis and examinations.

Candidates for this degree must meet the general requirements of the Graduate College regarding residence, language requirements, academic program, and thesis.

FELLOWSHIPS AND ASSISTANTSHIPS

The Katharine L. Sharp Fellowship was endowed in 1933 by the Library School Association as a memorial to the founder of the Library School. This fellowship is awarded biennially on recommendation of the faculty. It carries a stipend of $600 and exemption from tuition.

The Lois Wells Irwin Fellowship was established in 1955 as a memorial to Lois Wells Irwin, for thirty-two years an active member of the Board of Directors of the Quincy, Illinois, Public Library. Awarded annually upon recommendation of the faculty, the fellowship carries a grant of $500 and exemption from tuition.

A limited number of teaching and research assistantships are available to candidates for the master's and doctor's degrees. They carry exemption from tuition and a minimum basic salary of $3,000 for the nine-month academic year. Appointments are generally made for half time.

Several part-time work assistantships in the University Library are also open. Students in the Library School who have completed the undergraduate preparatory library science courses are eligible for these appointments. The minimum stipend for half-time library assistants is $1,800, plus exemption from tuition, for an eleven-month working year. These appointments are for one year and may be renewed once.

GRADUATE TEACHING FACULTY

Professors: R. B. Downs (Director of Library School), Thelma Eaton, A. H. Lancour, Rose B. Phelps, C. W. Stone.

Associate Professors: L. E. Bamber, Frances B. Jenkins, D. E. Strout.

Assistant Professors: Alice N. Fedder, Marie M. Hostetter, W. V. Jackson, M. Alice Lohrer.

Instructors: Viola James, B. M. Woods.

COURSES FOR GRADUATES

402. **Studies in Reading.** Designed to acquaint students with the major areas of investigation and library interest in reading. Special attention is given to studies of reading interests and habits. Class discussions are devoted to analysis of various studies and their implications for librarians. II; 1 unit. STONE.

403. **Methods of Investigation.** Survey of library literature with attention to examples of research in the library field, to elementary statistical procedures, and to the methods of investigation applicable to librarianship. Designed to prepare consumers rather than producers of research results. I; 1 unit. JENKINS.

405. **Library Administration.** Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. I; 1 unit. JENKINS.

406. **Library Service to Children and Young People.** The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young people in the public library. II; 1 unit. LOHRER.

407. **Cataloging and Classification, I.** The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and the Library of Congress subject headings. I; 1 unit. EATON.

408. **Cataloging and Classification, II.** The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloging department. II; 1 unit. Prerequisite: Library Science 407. EATON.

409. **Communication Roles and Responsibilities of Libraries.** Reviews briefly theories of learning and the communication process. Considers basic communication activities, problems, and research pertaining to normal library practices; the fostering of community relationships; maintaining intellectual freedom; effective use of mass media; and application of photographic and electronic aids. I; 1 unit. STONE.

410. **Adult Education.** Reviews the literature, history, and present scope of adult education in the United States; introduces various patterns of community organization for adult education and identifies significant educational programs conducted by libraries. Students become familiar with adult education methods, techniques, and materials used in many types of adult education programs. II; 1 unit. STONE.

411. **Bibliography of the Humanities and Social Sciences.** Detailed consideration of the bibliographical and reference materials in some ten subject fields, with training and practice in their use for solving questions arising in reference service. I; 1 unit. PHELPS.

412. **Bibliography of Science and Technology.** Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. II; 1 unit. JENKINS.

424. **Government Publications.** The nature and scope of American and British government publications; the problems of organization arising from their

form and from the methods of their production and distribution. II; 1 unit. PHELPS.

427. **Resources of American Libraries.** Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; types of library materials; and ways and means of developing research collections in special subject fields. I; 1 unit. JACKSON.

428. **Physical Problems of Libraries.** Consideration of principles and problems affecting the construction, remodeling, and equipment of the main types of libraries, with emphasis on their interrelationships, administrative implications, and recent developments. II; 1 unit. STROUT.

430. **Advanced Bibliography.** Designed to enable the student to utilize the varied resources of a large research library. Deals with the method of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. II; 1 unit. Prerequisite: Library Science 424 or consent of instructor. PHELPS.

431. **History of Libraries.** The development of libraries from those of Nineveh to the present day. Includes the Hellenic libraries, Roman libraries, monastery libraries of the Middle Ages; the work of the great book collectors in building up collections which were turned over to national libraries; the development of the great private, academic, and tax supported libraries which survive today. I; ½ to 1 unit. EATON.

432. **History of Books and Printing.** The origin and evolution of the alphabet and of scripts; the history of manuscript books; the invention and spread of printing; the account of the production and distribution of printed books. Emphasis is placed on the relation of books to social conditions in the various periods studied. II; 1 unit. EATON.

433. **Biological Literature and Reference Work.** Introduction to use of the indexes and abstract journals serving the biological sciences and related fields. The handling of pertinent general library aids, the preparation of scientific manuscripts, and the history of scientific societies also are considered. I, II; ¼ unit. BAMBER.

434. **Larger Units of Library Organization.** A study of cooperation, contracts, county and regional arrangements, and other devices for the provision of school and public library service by units covering more than a local area. Emphasis is on legal and administrative aspects, and not on operational procedures. II; 1 unit. STROUT.

436. **Development of the Library Catalog.** The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. II; 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor. EATON.

439. **Medical Literature and Reference Work.** Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources. II; 1 unit. Prerequisite: Consent of instructor. JENKINS.

441. **History of Children's Literature.** Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. I; 1 unit. LOHRER.

COURSES FOR ADVANCED GRADUATES

451. **Problems in Reference Service.** Examines the assumptions on which the interpretation of library resources is based, to consider the objectives of such service and the policies which lead to their attainment. I; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. PHELPS.

452. **Education for Librarianship.** A study of the development of library education in this country and abroad. Not a course in teaching methods, but designed to provide understanding of the philosophical foundations of the several training agencies through analysis of their methods, content, character of personnel, and relationship to the profession at various times. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. LANCOUR.

453. **Problems in Cataloging and Classification.** Analysis of the major technical and organizational problems of cataloging and classification, accompanied by a critical survey of the studies made in this area. I; 1 unit. Prerequisite: Master of Science in Library Science and courses comparable to Library Science 407 and 408, or consent of instructor. EATON.

454. **College and University Library Problems.** Investigation and review of administrative and educational problems in college and university libraries. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STROUT.

455. **Problems of Research in Reading.** Intensive analysis of selected research problems related to reading. Provides opportunity for independent investigation and for critical review of the major assumptions, methods, and conclusions of work done in particular fields; considers implications for the policy and practice of libraries. I; 1 unit. Prerequisite: Master of Science in Library Science and Library Science 402, or consent of instructor. STONE.

456. **Public Library Problems.** Study of major questions in the administration and organization of public libraries. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STONE.

457. **Librarianship and Society.** Emphasis is on the place of libraries today as social institutions and in relation to social trends. Consideration is given to the role of the librarian as an individual and as a professional worker in contemporary society. I; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STROUT.

458. **School Library Problems.** Examination of current practices and major problems of the school library field. Provides opportunity for independent investigation of selected problems. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. HOSTETTER.

459. **Principles of Research Methods.** Designed for persons planning to engage in research. Reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. I; 1 unit. Prerequisite: Knowledge of the principles of statistics; Master of Science in Library Science or consent of instructor. STONE.

461. **Descriptive Bibliography.** An introduction to descriptive bibliography, its methods, ideals, and purposes from the time of Bradshaw and Proctor to Greg and Bowers. Not a course in descriptive cataloging. S; 1 unit. Prerequisite: Open to advanced students from the Library School and other departments of the University with consent of instructor. EATON.

491. **Thesis.** Individual study and research. I, II; 1 to 4 units. STAFF.

COURSES FOR ADVANCED UNDERGRADUATES AND GRADUATES

301. **Literature of the Humanities and Social Sciences.** Designed to build a knowledge of the scope and significant characteristics of the several fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. I; 1 unit. STROUT.

302. **Literature of Science and Technology.** An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. II; 1 unit. JENKINS.

303. **Library Materials for Children.** The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard book selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. I, II; ½ to 1 unit. LOHRER.

304. **Library Materials for Adolescents.** The selection and use of library materials for adolescents in school and public libraries and community organizations. Aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. I, II; ½ to 1 unit. HOSTETTER.

306. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the cataloging, classification, and care of maps. Classes become familiar with the major cartobibliographical and related tools. II; ½ unit. WOODS.

308. **Audio-Visual Services in Libraries.** Considers the development of audio-visual work in libraries. Students are made aware of the range, types, and functions of the audio-visual materials, equipment, and services commonly provided, and of some of the organizational and technical problems met by specialists in the field. Laboratory sessions provide experience in working with materials and equipment. II; ½ unit (or 1 unit for candidates for the Master of Science in Library Science, upon approval of the instructor). STONE.

309. **Storytelling.** Fundamental principles of the art of storytelling including techniques of adaptation and presentation for children of various ages. Content and sources of materials; story cycles; methods of learning; practice in storytelling; planning the story hour for the school and public libraries, for recreational centers, for the radio, and television. Open to undergraduates and non-Library School students. I; ½ unit. LOHRER.

MANAGEMENT

The Department of Management offers graduate work either as a major or a minor leading to the degree of Master of Science, and as a minor for the Doctor of Philosophy degree.

For admission a student must have a grade-point average of 3.5 or above for that portion of the work which represents the last 50 per cent of the hours

earned toward the bachelor's degree, exclusive of required physical education and military training.

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration subjects such as accountancy, business law, economics, management, and marketing, at least six hours of which must have been in the field of management. To do minor work in this field, a student must have had at least twelve hours of work in the subjects named above, of which three must have been in management.

FELLOWSHIPS AND ASSISTANTSHIPS

Graduate students in management may apply for University fellowships which are awarded by the Graduate College. Applications must be filed with the Dean of the Graduate College before February 15 of the academic year preceding that for which the fellowship is desired.

Teaching assistantships are usually available for highly recommended candidates for any of the graduate degrees sponsored by the department. For information write the head of the department, 216 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professors: M. J. Mandeville (Head of Department), L. A. Bryan, P. M. Dauten, P. M. Green, E. G. Planty.
Assistant Professors: I. L. Heckmann, R. D. Wilson.

COURSES FOR GRADUATES

401. **Scientific Management.** A study of the development of modern industrial management and the principles and practices employed at the present time. I; 1 unit. Dauten.

402. **Scientific Management.** A study of the development of modern industrial management and the principles and practices employed at the present time. II; 1 unit. Dauten.

403. **Evolution and Development of Industry.** The evolution of industry from ancient times to the present; the social, economic, and political developments consequent upon the change from manufacturing for personal use to the present-day mass production industries. Consideration is given to the transition in organization for manufacture, technological changes, capital requirements, human relations, production processes, the location of industries, governmental control, and management responsibilities. I, II; 1 unit.

416. **Problems in Business Policy.** Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. I, II; 1 unit. Mandeville.

448. **Problems of Personnel Management.** Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. Deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. I; 1 unit. Prerequisite: Management 248 or equivalent; consent of instructor. Planty.

449. **Problems of Personnel Management.** Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. II; 1 unit. Prerequisite: Management 248, 448, or equivalent. PLANTY.

491. **Thesis.** I, II; 1 unit. GREEN, MANDEVILLE, PLANTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Management in Manufacturing.** Internal problems of production and efficient control in factories. I, II; ½ unit. Prerequisite: Management 101. WILSON.

311. **Administrative Policies and Organization.** Development of administrative organizations and the determination of policies for the integration of major activities of a business enterprise. I, II; ½ unit. Prerequisite: Management 101; Marketing 101. MANDEVILLE.

312. **Human Relations in Business.** Same as Labor and Industrial Relations 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. I, II; ½ unit. Prerequisite: Management 101 or equivalent. DAUTEN, PLANTY.

362. **Job, Wage, and Contract Administration.** An advanced, specialized treatment of the techniques, methods, and problems current in the wage and salary field. I, II; ½ unit. Prerequisite: Any one of the following courses or their equivalent: Psychology 145, 290, Economics 240, Management 248. HECKMANN.

MARKETING

Work may be done in the field of marketing for a major or a minor for the Master of Science degree and for a minor for the Doctor of Philosophy degree. To do major work in this field, a student must meet the general requirements for admission with full standing as described on page 15 and must have completed at least twenty hours of undergraduate work in marketing, management, economics, business law, or accountancy, at least six hours of which must have been in the field of marketing. To do minor work in this field a student must have had at least twelve hours of work in the subjects named above, of which three must have been in marketing.

GRADUATE TEACHING FACULTY

Professors: H. W. HUEGY (Head of Department), F. H. BEACH, P. D. CONVERSE, F. M. JONES, H. G. WALES.
Associate Professor: N. WEDDING.
Assistant Professors: R. H. COLE, R. S. HANCOCK, R. D. MILLICAN, R. MITCHELL.
Instructor: L. M. DEBOER.

COURSES FOR GRADUATES

401. **Marketing Principles and Problems.** Functional, commodity, and institutional methods of studying marketing with particular reference to the analysis and classifications of functions, commodities, and institutions. I, II; 1 unit. CONVERSE.

402. **Marketing Methods and Problems.** Selected problems in the operation and management of market institutions. I, II; 1 unit. CONVERSE.

407. **Prices and Price Policies.** An examination of the role of prices in our economy, and of price making under conditions of competition, monopoly, or monopolistic competition, with special emphasis on non-price competition; an examination of business pricing policies and of their acquisitive and social implications and significance. I, II; 1 unit. HUEGY.

415. **Merchandising Trends and Problems.** The literature, trends, policies, and organization problems involved in retail merchandising. I; 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor. JONES.

416. **Merchandising Policies and Problems.** The policies and problems relating to merchandise control, personnel, publicity, and promotion; recent literature and legislation. II; 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor. JONES.

421. **Analysis of Consumer Markets.** A study of consumers and their demands. I, II; 1 unit.

422. **Advanced Marketing Research.** Advanced marketing research theory, literature, objectives, techniques, and problems of marketing research. II; 1 unit. Prerequisite: Marketing 321 or consent of instructor. WALES.

471. **History of Marketing.** The development of marketing organizations, problems, and methods in the United States from colonial times to the present. Wholesaling, retailing, market growth, consumer buying habits, advertising, selling, pricing, legislation, trade channels. II; 1 unit. Prerequisite: Marketing 101 or consent of instructor. JONES.

472. **Sales Campaigns.** Problems in managing the sales force. I, II; 1 unit. BEACH.

481. **Advanced Advertising Principles.** Same as Journalism 481 and Mass Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Journalism 482 and Mass Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communication. Both non-quantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

491. **Thesis.** Thesis or independent study in the field of marketing. I, II; 0 to 2 units. CONVERSE, HUEGY, JONES, and others.

493. **Research in Special Fields.** I, II; ¼ to 2 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Contemporary Problems in Marketing Management.** The problems which marketing managers are currently facing and an analysis of the policy decisions they must make to operate effectively. I, II; ½ unit. Prerequisite: Marketing 101. CONVERSE, HUEGY, MITCHELL.

315. **Retail Buying.** Principles and procedures in buying for resale. Organization for buying, analysis of customer demand, model stock plans, sources of supply, resident buying, cooperative and central buying, foreign buying, selection of merchandise, and trade relations. I, II; ½ unit. Prerequisite: Marketing 211. HANCOCK.

321. **Marketing Research and Policies.** The basic techniques used in business research and specific research projects, and how their findings are used in

the formulation of marketing policies. I, II; ½ unit. Prerequisite: Marketing 101. DeBoer, Wales.

323. **Problems in Business Research.** Selected problems in the field of commercial research. I, II; ½ to 1 unit. Prerequisite: Marketing 321. DeBoer.

325. **Sales and Distribution Cost Analysis.** Basic techniques and principles of sales and distribution cost analysis for management control of marketing activities. I, II; ½ unit. Prerequisite: Marketing 101. Mitchell.

331. **Grain Grading and Marketing.** Same as Agricultural Economics 331 and Agronomy 331. Factors affecting the quality of grain crops; standards employed in their classification and grading on the commercial market; laboratory practice in grain grading; a trip to a commercial grain grading laboratory; economic problems and market operations in grain marketing. I; ½ unit. Prerequisite: Agricultural Economics 230 and Agronomy 121, or consent of instructor. Hieronymus, Weibel.

332. **Livestock Marketing.** Same as Agricultural Economics 332 and Animal Science 332. Problems and practices in marketing livestock. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. Broadbent.

333. **Marketing Horticultural Products.** Same as Agricultural Economics 333 and Horticulture 333. Products and their utilization; institutions, functions, and agencies; merchandising methods; economic problems involved in horticultural marketing. I; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or five hours of horticulture, or consent of instructor. Kelly.

334. **Marketing Dairy Products.** Same as Agricultural Economics 334 and Dairy Science 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. Bartlett.

345. **Credits and Collections.** Retail and mercantile credit and collection principles and practices. I, II; ½ unit. Prerequisite: Marketing 101. Cole, Hancock.

349. **Trade Association and Commercial Organization.** Principles of trade association and chamber of commerce organization and management. II; ½ unit. Hancock.

351. **Industrial Marketing.** The special problems involved in marketing materials, equipment, and supplies to manufacturers, other business firms, and institutions who use the goods in further production; determination of methods and policies appropriate to the goods and the marketing situations. I or II; ½ unit. Prerequisite: Marketing 101 or 272, or consent of instructor. Coolsen.

372. **Advanced Salesmanship.** An application of sales techniques to actual selling situations. Students make sales presentations, and critical appraisals are given. I, II; ¼ unit. Prerequisite: Marketing 271. Tonning, Wales.

373. **Sales Management.** Modern sales organization; selling problems of manufacturers, wholesalers, and retailers; management of salesmen. I, II; ½ unit. Prerequisite: Marketing 271. Beach.

382. **Advertising Copy and Layout.** Same as Journalism 382. Theory and practice of advertising copy writing and layout for newspaper, magazine, and direct mail; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. I, II; 1 unit. Prerequisite: Journalism 204; Marketing 281. Sargent.

383. **Advertising Media.** Same as Journalism 383. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. I, II; ½ unit. Prerequisite: Marketing 281. MULLEN.

384. **Advertising Campaigns.** Same as Journalism 384. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements — copy and layout. Graduate students do not receive credit for both Marketing 384 and 387. I, II; ½ unit. Prerequisite: Marketing 282 or 382; and 383. WEDDING.

385. **Advertising Promotion and Sales.** Same as Journalism 385. Sales problems, advertising promotion, advertising research, market research. I, II; ½ unit. Prerequisite: Marketing 281. MCCLURE.

386. **Radio and Television Advertising.** Same as Journalism 386. Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. I, II; ½ unit. Prerequisite: Marketing 281. SANDAGE.

387. **Advertising Policies and Problems.** Same as Journalism 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Consideration is given to management problems at both the national and retail levels. Graduate students do not receive credit for both Marketing 384 and 387. I, II; ½ to 1 unit. Prerequisite: Marketing 281. WEDDING.

MASS COMMUNICATIONS

The graduate program leading to the degree of Doctor of Philosophy in Mass Communications is administered by an interdepartmental committee appointed by the Dean of the Graduate College.

The program is designed to apply the methods and disciplines of the social sciences (supported where necessary by the arts and natural sciences) to the basic problems of human communication and is intended for students whose academic and professional experience qualifies them to study mass communications and whose plans for careers are such as to make this interdepartmental degree more desirable than a degree in one of the social sciences. Among such careers may be the teaching of journalism, radio, or other communication subjects, research in the fields of public opinion or audience study, and executive jobs in the communication industries requiring breadth, perspective, and a scientific background.

Prerequisites to admission to this program are at least one course in each of the following subjects: psychology, sociology, political science, economics, and statistics. If a student lacks one of these prerequisites, he may be admitted probationally while he makes up the deficiency, but he may not count that course among the twenty-four units required for the degree.

A candidate for this degree is expected to meet the following requirements:

(1) A total of twenty-four units of graduate work, among them:

(a) Four or more units of graduate courses in mass communications, such as Mass Communications 390, 391, 421, 426, 444, 446, 462, 471, 473, 474, 481.

(b) One or more units in research methods or field studies, such as Mass Communications 370, 392, 455, 482, 490.

(c) Two minors in social sciences or, in special cases, in other areas approved by the administrative committee. A minor is here defined as three or more graduate units.

(d) Electives as needed to make twenty-four units and as approved by the administrative committee. These electives are often used to broaden the background in social science, to strengthen the minors, or, especially in the case of a candidate preparing for experimental work, to add more work in statistics and higher mathematics.

(2) Reading knowledge of two modern foreign languages, preferably French, German, or Russian.

(3) A written examination covering the broad field of communication. The candidate is eligible to take this examination when he has earned sixteen units and has passed his foreign language examinations.

(4) A satisfactory dissertation on some topic in mass communications.

(5) A final examination centered on, but not restricted to, the field of the dissertation.

A candidate for the degree of Doctor of Philosophy who wishes to minor in mass communications should select four, three, or two courses (according to the requirements of his major department) from the following list. Such a candidate is expected to have a social science background sufficient for such courses as he chooses. If he has any doubt as to the adequacy of his background, he should consult the chairman of the administrative committee who will also advise him as to desirable combinations and sequences of courses.

Inquiries for further information should be addressed to Professor F. S. Siebert, 119 Gregory Hall.

INSTITUTE OF COMMUNICATIONS RESEARCH

Students in the mass communications program frequently participate in the research activities of the Institute of Communications Research and have access to the research facilities of this unit.

The institute is an interdepartmental group engaged in the study of problems relating to the communications process and its use in society. Membership includes a senior staff appointed part time in the institute and part time in related departments, a junior staff of research workers, and a number of research assistants.

ASSISTANTSHIPS

A number of research assistantships in the Institute of Communications Research and teaching assistantships in the School of Journalism and Communications are available. For information, inquire of Professor F. S. Siebert, 119 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: F. S. Siebert (Chairman of Administrative Committee), J. W. Albig, C. B. Hagan, C. E. Osgood, C. H. Sandage, D. W. Smythe.

COURSES FOR GRADUATES

421. **Government and the Economic Order.** Same as Political Science 421. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. I or II; 1 unit. Hagan.

426. **Experimental Psychology of the Communication Process.** Same as Psychology 426. A critical survey of methods and theories in the psychological study of the communication process, with emphasis upon the development of sym-

bolic behavior, experimental semantics, and frequency studies. Application is made to various problems in social science. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology or equivalent. OSGOOD.

444. **Seminar in Public Opinion.** Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. I, II; 1 unit. ALBIG.

446. **Opinion Polling Analysis.** Same as Sociology 446. The study of current polling practices, organizations, and findings. Evaluation of results in terms of the prediction and interpretation of social behavior. I, II; 1 unit.

455. **The Measurement of Attitude and Opinion.** Same as Psychology 455. A systematic study of scaling and sampling methods in social psychology, with accompanying laboratory work and practice in methods of analyzing data. Recent developments in theory and methods of attitude scaling are emphasized. I or II; 1 unit. Prerequisite: Psychology 406 or equivalent. THISTLETHWAITE.

462. **Seminar in Radio and Television.** Same as Journalism 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. II; 1 unit. SKORNIA.

471. **Theory of Communications.** Same as Journalism 471. Nature of the communication process; development of communication patterns and institutions; principles governing the control and support of mass communications; content and audience study; effects of communication; and relation of mass communications to public opinion and group action. I; 1 unit. TANNENBAUM.

473. **History and Theory of Freedom of the Press.** Same as Journalism 473. Development of the Anglo-American press system; philosophical bases of competing press systems. I; 1 unit. PETERSON.

474. **Government and Mass Communications.** Same as Journalism 474. Current legal, constitutional, and administrative problems of media of mass communications; contemporary issues resulting from the restrictive, regulatory, and supplementary activities of government in the field of mass communications. II; 1 unit. SIEBERT.

481. **Advanced Advertising Principles.** Same as Journalism 481 and Marketing 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Journalism 482 and Marketing 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both non-quantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

490. **Research in Special Topics.** Same as Journalism 490. Students may re-register for a total of 2 units. I, II; ½ to 1 unit. Prerequisite: Consent of instructor. STAFF.

492. **Thesis.** I, II; 1 to 4 units. Students may re-register for a total of eight units. Prerequisite: Consent of chairman and thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

370. **Applied Statistical Analysis.** Same as Economics 370. A general course in statistical methods applied to the subject matter fields of the College of Commerce and Business Administration. Intended principally for those students who have entered or intend to enter a program of graduate study

and whose training in the basic statistical methods employed in these disciplines is inadequate. Credit is not given for Economics 370 in addition to Economics 271. I; 1 unit. Prerequisite: Admission to candidacy for a graduate degree with no more than one course in economic statistics. NEISWANGER.

390. **Economics of Communications, I.** Same as Economics 390 and Journalism 390. Economic problems associated with the public means of communication: telephone, telegraph, the postal service, the various forms of radio broadcasting including FM, television, and facsimile, and the use of radio for the safety and efficiency of transportation, protective services, etc. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

391. **Economics of Communications, II.** Same as Economics 391 and Journalism 391. Economic problems associated with the following means of communication: motion pictures, newspapers, magazines, and books. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. SMYTHE.

392. **Research Methods for Press, Radio, and Television.** Same as Journalism 392. An introduction to relevant research methods and practices for mass media personnel who need to use research as a tool of management and policy, order research, and interpret research. Lectures, readings, and laboratory practice. II; ½ unit. TANNENBAUM.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the degrees of Master of Arts or Master of Science and Doctor of Philosophy in Mathematics and in Statistics. Research for the doctor's degree in mathematics can be carried out in the fields of algebra, analysis, applied mathematics, geometry, and topology.

For information concerning applied mathematics, see page 28.

MATHEMATICS

For admission to full standing, a beginning graduate student must have a grade-point average of not less than 3.5 for that portion of his undergraduate work representing the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are admitted on limited status.

In order to begin graduate work without deficiencies with a major in mathematics, a student should have had twenty hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and one year of more advanced work in one or more of the fields of algebra, analysis, and geometry.

Candidates for a Doctor of Philosophy degree taking a sole minor in mathematics are expected to complete four units approved by the department. Those taking a first or second minor are required to complete at least two units beyond calculus.

The more technical courses offered by the department are arranged mainly in cycles of two or of three years, so that a properly qualified student usually has opportunity to take any particular course at some time during the three years of residence required for the doctor's degree.

Candidates for the degree of Master of Science in the Teaching of Mathematics must earn four units in mathematics (two units of which are electives), two units in education, and two units in electives. Requirements are Mathematics 317 or 327, one unit; Mathematics 318 or 328, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312,

one unit. The elective courses in mathematics and the other electives must be selected with the approval of the adviser. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have the same grade-point average as that required by the department. Students on limited status are not admitted to this program. The adviser for candidates for this degree is Professor H. R. Brahana, 357 Mathematics Building.

Candidates for the degree of Master of Science in the Teaching of Mathematics and the Physical Sciences must earn two units in mathematics, one unit in chemistry, one unit in physics, two units in education, and two units in electives. Requirements are Mathematics 347 or 343, one unit; Mathematics 348 or 345, one unit; Chemistry 240, one unit; Physics 322, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives may be in mathematics, in education, in chemistry, or in physics. Students applying for admission must have a grade-point average of at least 3.5 for that portion of work which represents the last 50 per cent of the hours earned for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. The adviser for candidates for this degree is Professor H. R. Brahana, 357 Mathematics Building.

ASSISTANTSHIPS IN MATHEMATICS

Graduate assistantships are available for a limited number of highly qualified degree candidates. The department does not approve teaching loads in excess of half time for assistants. Inquiries and requests for application forms should be addressed to the Department of Mathematics, 251 Mathematics Building.

STATISTICS

This program of study is developed for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology.

For admission to full standing a beginning graduate student must have a grade-point average of not less than 3.5 for that portion of his work which represents the last 50 per cent of the hours completed to secure a bachelor's degree, exclusive of required physical education and military training. The completion of a thorough course in calculus is also a prerequisite to admission. A course in advanced calculus, while not required, is found helpful. Students are admitted on limited status.

This program is administered by the Department of Mathematics with the help of a small interdepartmental advisory committee. The thesis for the degree of Doctor of Philosophy must show capacity for important original contributions to one or more of the following: development of new statistical ideas and methods; improvement of applications of statistical methods; and new uses of statistical methods in some field of application. The work of individual students is supervised by one adviser if the courses referred to as electives in the following are taken in general statistics; otherwise by two advisers, one representing the field of general statistics and one mathematics or a field of application.

A candidate for the degree of Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College (note the requirement of a minor of at least two units in an area of study other than statistics or mathematics), must complete the following courses: (1) Mathematics 315,

347, or equivalents; (2) eight units of statistics of which at least four must be courses at the 400 level, selected from a list of courses prepared by the Mathematics Department and including all courses in statistics listed jointly by the Mathematics Department and areas of application; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

A candidate for the degree of Master of Arts in Statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be 400 courses, selected from a list as in (2) above; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 21-26) he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

The courses required under (4) above are determined by the interests of the student. They may be taken in general statistics, in mathematics, or in an area of application. Thus, the graduate degrees in statistics permit considerable variation in the division of emphasis between general statistics and the area of application. A graduate student in statistics has two advisers, one for statistical theory, one for the area of application.

Candidates for a Doctor of Philosophy degree taking a sole minor in statistics are expected to have completed a course in calculus and are required to complete four units of work in statistics having calculus as prerequisite. Those taking a first or second minor in statistics are required to complete at least two units of work in statistics having calculus as prerequisite.

ASSISTANTSHIPS IN STATISTICS

Graduate assistantships, for not more than half time, are available for a limited number of highly qualified degree candidates. Inquiries and requests for application forms should be addressed to the Statistical Research Laboratory, Department of Mathematics.

The following members of the Department of Mathematics give courses intended primarily for graduate students in statistics: Professors W. G. Madow, Chairman, Statistical Research Laboratory, C. R. Blyth, D. L. Burkholder, and J. L. Doob.

GRADUATE TEACHING FACULTY

Professors: S. S. Cairns (Head of Department), R. Baer, D. G. Bourgin, H. R. Brahana, M. M. Day, J. L. Doob, G. P. Hochschild, P. W. Ketchum, H. Levy, W. G. Madow, C. W. Mendel, H. J. Miles, J. P. Nash, A. H. Taub, W. J. Trjitzinsky.

Associate Professors: P. T. Bateman, C. R. Blyth, W. A. Ferguson, F. E. Hohn, M. E. Munroe, J. W. Peters, R. E. Pingry, L. L. Steimley, H. E. Vaughan, W. Wilson.

Assistant Professors: Beulah M. Armstrong, R. G. Bartle, O. K. Bower, J. R. Büchi, D. L. Burkholder, Josephine H. Chanler, N. T. Hamilton, N. S. Hawley, Jr., A. Heller, V. A. Hoersch, J. Landin, R. G. Langebartel, D. E. Muller, Echo D. Pepper, I. Reiner, Jewell E. Schubert, E. J. Scott, M. Suzuki, J. A. Zilber.

Instructors: Corinne R. Hattan, W. M. Zaring.

COURSES FOR GRADUATES

401. **Theory of Fields.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

402. **Linear Algebra.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

403. **Theory of Rings.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

404. **Group Theory.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

407. **Representation Theory and Classical Groups.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

408. **Lie Groups.** I, II; 1 unit. Prerequisite: Mathematics 332, 404, and 441.

414. **Logical Foundations of Mathematics.** Same as Philosophy 414. II (1956-1957 only); 1 unit. Prerequisite: A course in symbolic logic or consent of instructor.

415. **Advanced Topics in the Theory of Groups.** I, II; 1 unit. Prerequisite: Consent of instructor.

416. **Advanced Topics in Abstract Algebra.** I, II; 1 unit. Prerequisite: Consent of instructor.

420. **Projective Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328.

422. **Algebraic Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328.

423. **Differential Geometry.** I, II; 1 unit. Prerequisite: Mathematics 343.

424. **Riemannian Geometry.** I, II; 1 unit. Prerequisite: Mathematics 420, or 423, or consent of instructor.

426. **Differential Geometry in the Large.** I, II; 1 unit. Prerequisite: Mathematics 332 or 423, or consent of instructor.

427. **Foundations of Geometry.** I, II, 1 unit. Prerequisite: Consent of instructor.

428. **Topics in Geometry.** I, II; 1 unit. Prerequisite: Consent of instructor.

430. **Elementary Geometry from a Modern Viewpoint.** Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern approach. I, II; 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

431. **Number, Length, Area.** Deals with the development of the integers, rational numbers, real numbers, variables, functions, limits, area, length, volume. The principal emphasis is upon the mathematical needs of the secondary school teacher. I, II; 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

432. **Separable Metric Spaces.** I, II; 1 unit. Prerequisite: Mathematics 332.

434. **Combinatorial Theory of Polyhedra.** I, II; 1 unit. Prerequisite: Mathematics 333.

438. **Topics in Topology.** I, II; 1 unit. Prerequisite: Consent of instructor.

439. **Seminar in Topology.** I, II; 1 unit. Prerequisite: Consent of instructor.

440. **Theory of Functions of a Complex Variable, I.** I, II; 1 unit. Prerequisite: Mathematics 348 and 349, or consent of instructor.

441. **Functions of Real Variables.** I, II; 1 unit. Prerequisite: Mathematics 347.

442. **Measure and Integration.** I, II; 1 unit. Prerequisite: Mathematics 347; consent of instructor.

444. **Partial Differential Equations.** I, II; 1 unit. Prerequisite: Consent of instructor.

445. **Theory of Functions of a Complex Variable.** I, II; 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. **Hilbert Space.** I, II; 1 unit. Prerequisite: Mathematics 442.

447. **Banach Spaces.** I, II; 1 unit. Prerequisite: Mathematics 442.

449. **Normed Rings.** I, II; 1 unit. Prerequisite: Mathematics 318 and 446 or 447.

450. **Semi-Ordered Spaces.** I, II; 1 unit. Prerequisite: Mathematics 446 or 447.

451. **Theory of Probability.** I, II; 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** I, II; 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 317 and 348.

454. **Analytic Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods of Physics.** I, II; 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods of Physics.** I, II; 1 unit. Prerequisite: Mathematics 455.

457. **High-Speed Computing.** I, II; 1 unit. Prerequisite: Consent of instructor.

459. **Topics in Hydrodynamics.** I, II; 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy 424 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. McVittie.

464. **Dynamics of the Earth's Atmosphere.** Same as Astronomy 464 and Physics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

468. **Topics in Analysis.** I, II; 1 unit. Prerequisite: Consent of instructor.

469. **Seminar in Analysis.** I, II; 1 unit. Prerequisite: Consent of instructor.

470. **Statistical Decision Functions.** Statistics from the point of view of decision making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to non-sequential and sequential decision making in practice. I, II; 1 unit. Prerequisite: Consent of instructor.

472. **Econometrics.** Same as Economics 472. Application of the principles of mathematical statistics to estimation of economic relationships. II; 1 unit. Prerequisite: Mathematics 363; consent of instructor.

473. **The Theory of Testing Hypotheses.** Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. I, II; 1 unit. Prerequisite: Consent of instructor.

474. **The Theory of Estimation.** Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. I, II; 1 unit. Prerequisite: Consent of instructor.

478. **Topics in Statistics.** I, II; 1 unit. Prerequisite: Consent of instructor.

490. **Reading Course.** I, II; 1 to 2 units. Prerequisite: Consent of instructor.

491. **Research and Thesis.** I; 1 to 4 units. Prerequisite: Consent of instructor. Staff.

492. **Research and Thesis.** II; 1 to 4 units. Prerequisite: Consent of instructor. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Fundamental Concepts of Mathematics.** I; 1 unit. Prerequisite: One year of calculus or consent of instructor.

302. **Fundamental Concepts of Mathematics.** II; 1 unit. Prerequisite: One year of calculus or consent of instructor.

305. **Teachers' Course.** A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry. Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic. Topics suitable for presentation for superior high school students are also considered. I, II; ½ to 1 unit. Prerequisite: One year of calculus or consent of instructor.

311. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. I; 1 unit. Prerequisite: One year of calculus or consent of instructor.

312. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. II; 1 unit. Prerequisite: One year of calculus or consent of instructor.

315. **Linear Transformations and Matrices.** I, II; 1 unit. Prerequisite: One year of calculus.

317. **Introduction to Higher Algebra.** I; 1 unit. Prerequisite: One year of calculus.

318. **Introduction to Higher Algebra.** II; 1 unit. Prerequisite: Mathematics 317.

327. **Introduction to Higher Geometry.** I; 1 unit. Prerequisite: One year of calculus.

328. **Introduction to Higher Geometry.** II; 1 unit. Prerequisite: Mathematics 327.

332. **Topological Spaces.** I, II; 1 unit. Prerequisite: Credit or registration in Mathematics 347.

333. **Combinatorial Topology.** I, II; 1 unit. Prerequisite: Mathematics 343.

341. **Differential Equations.** I, II; 1 unit. Prerequisite: One year of calculus.

342. **Differential Equations.** I, II; 1 unit. Prerequisite: Mathematics 341.

343. **Advanced Calculus.** I, II; 1 unit. Prerequisite: One year of calculus.

345. **Differential Equations and Orthogonal Functions.** I, II; 1 unit. Prerequisite: One year of calculus.

346. **Complex Variables and Applications.** For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take Mathematics 348. Credit is not given for both Mathematics 346 and 348. I, II; 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. **Introduction to Higher Analysis: Real Variables.** I, II; 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. **Introduction to Higher Analysis: Complex Variables.** I, II; 1 unit. Prerequisite: Mathematics 347.

349. **Introduction to Higher Analysis: Real Variables II.** I, II; 1 unit. Prerequisite: Mathematics 347.

358. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. I, II; ½ unit. Prerequisite: Mathematics 111 or 112.

359. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. I, II; ½ unit. Prerequisite: Mathematics 358.

361. **Theory of Probability.** II; 1 unit. Prerequisite: One year of calculus.

362. **Finite Differences.** I; 1 unit. Prerequisite: One year of calculus.

363. **Advanced Statistics.** I, II; 1 unit. Prerequisite: One year of calculus.

364. **Advanced Statistics.** I, II; 1 unit. Prerequisite: Mathematics 363.

369. **The Ideas and Methods of Statistics.** The modern formulation of the ideas of statistical inference with applications to the testing of various statistical hypotheses. The treatment stresses not the details but the general nature of proofs. The interpretation of the ideas in practice is given. I, II; 1 unit. Prerequisite: Differential and integral calculus and a first course in statistics.

371. **Actuarial Theory.** I; 1 unit. Prerequisite: One year of calculus.

375. **Nonparametric Inference.** Nonparametric tests of hypotheses concerning means, variances, regression, and correlation coefficients; methods depending on ranks; the efficiency of nonparametric tests. I, II; 1 unit. Prerequisite: Mathematics 361 or 363.

377. **Sequential Inference.** An introduction to quality control, sampling inspection, and sequential analysis, with particular emphasis on the latter; control charts; single, double, and multiple sampling inspection methods; sequential probability ratio tests; efficiency of sequential tests; expected number of observations necessary; operating characteristic and average sample number curves. I, II; 1 unit. Prerequisite: Mathematics 363.

381. **Vector and Tensor Analysis.** I; 1 unit. Prerequisite: Mathematics 343, or equivalent, or consent of instructor.

382. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** II; 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

384. **Logical Design of Automatic Digital Computer Circuits.** Same as Electrical Engineering 384. I, II; 1 unit. Prerequisite: Senior standing; consent of instructor.

385. **Digital Computer Programming.** I, II; 1 unit. Prerequisite: Senior standing; consent of instructor.

386. **Laplace Transforms.** I, II; 1 unit. Prerequisite: Mathematics 343.

387. **Introduction to Numerical Methods.** I or II; 1 unit. Prerequisite: Mathematics 343.

388. **Mathematical Methods in Engineering and Science.** I or II; 1 unit. Prerequisite: Mathematics 343.

391. **Boolean Algebras with Applications to Computer Circuits, I.** An introduction to Boolean algebra with a discussion of the elementary applications to set theory, logic, and both relay and electronic switching circuits. The Harvard chart method and other methods for circuit simplification are treated both as applied to single output and multiple output circuits. I, II; ½ to 1 unit. Prerequisite: Senior standing; consent of instructor.

392. **Boolean Algebras with Applications to Computer Circuits, II.** The notion of time as a parameter is introduced into the theoretical treatment of switching circuits. Examples of synthesis of time-dependent circuits are given using mathematical techniques. I, II; ½ to 1 unit. Prerequisite: Mathematics 391.

MECHANICAL ENGINEERING

(Including Industrial Engineering)

The Department of Mechanical Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. Advanced study and

professional training are offered in the general fields of power, design, and production.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements for the degree of Bachelor of Science in mechanical engineering at the University of Illinois, together with a grade-point average of at least 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

Courses numbered in the 300 group are those open to advanced undergraduate and graduate students, and those in the 400 group are for graduate students only. In registering for a course with variable credit, as one-half to one and one-half units, each student puts on his program card the number of units for which he intends to take the course. Courses numbered in the 300 group have variable credits of one-half to three-fourths unit; the one-half unit represents credit for work corresponding to advanced undergraduate study, the additional one-fourth unit requires a term paper.

Except under unusual circumstances the maximum number of credits which is permitted in any course whose number ends in 8 or 9 is three units toward the requirements for a master's degree. An additional four units of credit are permitted for candidates working toward a doctor's degree. In most cases the research work conducted in these laboratory investigations can be reported in the thesis submitted for fulfillment of the requirements for each degree. A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is required if a thesis is not included.

For further information see the booklet "Graduate Study and Research in Mechanical Engineering." Copies may be obtained from the Department of Mechanical Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the chairman of the graduate committee, Department of Mechanical Engineering.

For information concerning applied mathematics, see page 28.

FELLOWSHIPS AND ASSISTANTSHIPS

The Graduate College offers fellowships to worthy students including those who intend to specialize in mechanical engineering. In addition, the Department of Mechanical Engineering has industrial fellowships which vary in number from year to year. Applications for Graduate College fellowships and industrial fellowships should be sent to the Dean of the Graduate College.

A limited number of part-time teaching assistantships are available to students of superior attainment with either a Bachelor of Science or Master of Science degree in mechanical engineering. The stipend is $1,500 for a half-time assistant and $750 for a quarter-time assistant, for a school year of two semesters, and exemption from tuition, laboratory, library, and supply fees. A half-time assistant can carry up to three units of graduate work each semester. Application forms may be obtained from the head of the department, 144 Mechanical Engineering Building.

A limited number of half-time research assistantships are offered by the Engineering Experiment Station. The recipients of these assistantships agree to hold them for two school years. The stipends and other terms are the same as those for teaching assistant. Application forms may be obtained from the Dean of the College of Engineering, 106 Civil Engineering Hall.

GRADUATE TEACHING FACULTY

Professors: N. A. Parker (Head of Department), E. L. Broghamer, B. T. Chao, L. E. Doyle, W. N. Espy, J. R. Fellows, W. S. Harris, E. F. Hebrank, J. A. Henry, W. L. Hull, S. Konzo, H. H. Korst, R. F. Larson, A. Longacre (Cooperating), R. J. Martin, D. G. Ryan, H. J. Schrader (Cooperating), F. Seyfarth, K. J. Trigger.

Associate Professors: H. D. Bareither, J. R. Carroll, G. W. Harper, L. C. Pigage, E. I. Radzimovsky.

Assistant Professors: W. E. Bair, W. L. Chow, C. H. McClay, T. W. Price, W. F. Stoecker.

Mechanical Engineering

COURSES FOR GRADUATES

401. **Thermodynamics.** Application of thermodynamics to the analysis and solution of engineering problems involving energy transfer and conversion. I; 1 unit. Prerequisite: One year course in thermodynamics. Espy.

402. **Thermodynamics of Gaseous Equilibrium.** Application of thermodynamics to analysis of combustion of gases used as working media in power production. II; 1 unit. Prerequisite: One year course in thermodynamics. Espy.

403. **Advanced Combustion.** A study of the theories of combustion. Solid, liquid, and gaseous fuels as used in engineering structures. Emphasis is on experimental methods in combustion. I, II; 1 unit. Prerequisite: Undergraduate courses in thermodynamics and differential equations. Bair, Price.

404. **Gas Dynamics.** Introduction to theoretical gas dynamics; properties of compressible real fluids; fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multi-dimensional problems. I; 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. Korst.

405. **Heat Transfer.** Analysis of the methods and mechanisms of heat transfer: dimensional analysis method, design of heat exchangers, transient state heat transfer. Special problems in insulation and heat transfer. II; 1 unit. Prerequisite: Undergraduate course in heat transfer. Chao, Larson.

406. **Heat Conduction in Solids.** Fundamentals; general differential equation of heat conduction; methods of solution; steady state heat flow; transient heat flow, one and two dimensions; periodic flow of heat; internal heat source in solids. I; 1 unit. Prerequisite: Undergraduate course in differential equations. Chao.

407. **Selected Topics in Gas Dynamics.** Theoretical analyses of non-steady processes including scavenging, pulse jet, shock tube, and comprex compressor. Includes an introduction to high velocity laboratory techniques. II; 1 unit. Prerequisite: Mechanical Engineering 404. Korst.

408. **Laboratory Investigations in Thermodynamics.** Special investigations involving thermodynamic analysis, thermodynamic properties, and performance of physical and chemical systems. I, II; ½ to 1½ units. Prerequisite: One year course in thermodynamics; one half-year course in power laboratory. Bair, Chow, Espy, Korst.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigations in flow, metering, heat transfer, heat exchanger performance and design. I, II; ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. Bair, Chao, Chow, Korst, Larson, Price.

413. **Industrial Control Systems.** Study of basic elements of process control systems and process characteristics, particularly of thermal and mechanical processes. II; 1 unit. Prerequisite: Mechanical Engineering 311 or equivalent. McCLAY.

421. **Heating and Air Conditioning.** Advanced study of heating, ventilating, and air conditioning. Factors affecting heat loss and heat gain of building, physiological effects of environment, equipment design of heat transfer equipment. Individual problems. I; 1 unit. Prerequisite: Undergraduate course in heating, ventilating, and air conditioning. BAREITHER, CARROLL, FELLOWS, KONZO.

423. **Refrigeration Theory and Application.** Advanced study of processes and cycles; design problems; and special applications. II; 1 unit. Prerequisite: Undergraduate course in refrigeration. MARTIN, STOECKER.

428. **Laboratory Investigations in Refrigeration.** Special investigations in refrigeration. I, II; ½ to 1½ units. MARTIN, STOECKER.

429. **Laboratory Investigation in Heating and Air Conditioning.** Special investigations in heating, ventilating, and air conditioning. I, II; ½ to 1½ units. Prerequisite: Two semesters of power laboratory, or equivalent. BAREITHER, CARROLL, FELLOWS, HARRIS, KONZO.

432. **Theory of Rotary Compressors.** Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbo-compressors; regulation; rotary positive blowers. II; 1 unit. Prerequisite: Mechanical Engineering 205 and 206; Theoretical and Applied Mechanics 232 or Aeronautical Engineering 211 and 212. KORST.

433. **Prime Movers.** Steam and diesel engines, and steam, gas, and hydraulic turbines as power prime movers; detailed analysis of flow and internal losses in steam and hydraulic turbines. II; 1 unit. Prerequisite: Undergraduate courses in power plant equipment and thermodynamics.

438. **Laboratory Investigations in Power Machinery.** Special investigations in power machinery, such as turbines, engines, fans, and compressors. I, II; ½ to 1½ units. Prerequisite: One year course in power laboratory. BAREITHER, HEBRANK, HULL.

441. **Machine Design.** A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper consideration of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. RYAN.

443. **Dynamics of Machinery.** Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, critical speeds, and vibrations in shafts; gyroscopic action in machines; flywheels, governors, and special topics. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER, RYAN.

445. **Design of Internal Combustion Engines.** Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determination of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. I; 1 unit. Prerequisite: Under-

graduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

448. **Laboratory Investigations in Machine Design.** Special investigations in machine design. I, II; ½ to 1½ units. BROGHAMER, RADZIMOVSKY, RYAN.

451. **Metal Cutting.** A study of the theoretical factors involved in metal cutting and forming. Basic mechanics of machining processes; friction and surface finish; temperatures developed during machining operations and the effect upon chip formation. Analysis of experimental data. Lecture and discussion periods. Survey of current literature and special topic assignments. I; 1 unit. Prerequisite: Undergraduate courses in advanced metal processing and heat treatment of metals or physical metallurgy. TRIGGER.

458. **Laboratory Investigations in Production.** Special investigations in the field of production, particularly in materials processing, metal cutting, and production engineering. I, II; ½ to 1½ units. HARPER, PIGAGE, TRIGGER.

468. **Laboratory Investigations in Railway Mechanical Engineering.** Special investigations in the field of railway mechanical engineering. I, II; ½ to 1½ units. Prerequisite: Bachelor of Science degree in mechanical engineering. SCHRADER.

491. **Thesis (M.S. or Ph.D.).** I; ½ to 4 units. STAFF.

493. **Seminar.** Presentation and discussion of significant developments in mechanical engineering. I, II; no credit. KONZO.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Nuclear Power Engineering.** Principles of release and exploitation of nuclear energy; uranium fission and the controlled chain reaction, reactor types and design principles; radiation hazards and shielding, adaptations and economics. II; ½ to ¾ unit. LARSON.

303. **Fuels and Combustion.** Fuel resources; composition and specification of natural and manufactured fuels; combustion stoichiometry; fuel calorimeters; coal, oil, and gas burners; fire box and chimney design; smoke abatement. I; ½ to ¾ unit. Prerequisite: Chemistry 101 and 104 and Mechanical Engineering 207, or equivalent. FELLOWS.

305. **Thermodynamics of High-Velocity Flow.** The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines. I, II; ½ to ¾ unit. Prerequisite: Mechanical Engineering 206 or consent of instructor. CHOW.

311. **Instrumentation and Measurements.** Instruments and measuring equipment for flow, temperature, pressure, speed, and gas analysis. I, II; ½ to ¾ unit. KONZO, MCCLAY.

314. **Lubrication.** The theories of lubrication; manufacture and properties of lubricants; methods of testing; lubrication methods and appliances. A study of the lubrication requirements of machines of many kinds. I; ½ to ¾ unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. RADZIMOVSKY.

322. **Heating, Ventilating and Air Conditioning Design.** Theory and design of heating, ventilating, and air conditioning systems. I, II; ½ to ¾ unit. Prerequisite: Mechanical Engineering 252 or 260. BAREITHER, CARROLL, KONZO.

332. **Theory of Internal Combustion Engines.** Study of reciprocating engine cycles, including thermodynamics and combustion, considering such factors

as fuel-air mixture, variable specific heats, chemical equilibrium and dissociation and heat losses; supercharging; flow through valves and manifolds; mixture distribution; bearings and lubrication; and effects of variables on performance. II; ½ to ¾ unit. Prerequisite: Undergraduate course in internal combustion engines. HULL.

346. **Power Plant Design.** A critical study of the functions, relative performance characteristics, economics, selection, and correlation of equipment for a modern power generating station. I, II; ½ to ¾ unit. Prerequisite: Consent of instructor. SEYFARTH.

363. **Railway Motive Power.** A technical study of the types of motive power used on railways and the conditions under which they operate. Special emphasis is on Diesel, gas turbine and steam locomotives; consideration is also given to special types, operating conditions, economics, train resistance, tractive force, speed time and distance curves. Problem in stopping trains, preparation of time tables, servicing new and old equipment and terminal and general repair facilities. II; ½ to ¾ unit. SCHRADER.

371. **Foundations for Nuclear Engineering.** To collect and correlate the physical and chemical facts that lead to nuclear engineering, such as the mass-energy relation, binding energies, natural and artificial radioactivity, the discovery of the neutron, nuclear scattering, and elements of kinetic theory. I; ½ to ¾ unit. Prerequisite: Consent of instructor. LONGACRE.

Industrial Engineering

COURSES FOR GRADUATES

453. **Methods and Measurements of Industrial Work.** Advanced theoretical analysis of factors affecting determination of economical methods, method standards, and time standards for industrial operations. Special investigations and term paper. I; 1 unit. Prerequisite: Undergraduate course in motion and time study, and production control. PIGAGE.

454. **Production Engineering.** Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. II; 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

350. **Tool Engineering Analysis.** Solution of advanced problems by analytical methods with special attention to problems of dimensional planning, economics, design of tools, metal forming, and shearing tools. II; ½ to ¾ unit. Prerequisite: Industrial Engineering 282 or equivalent. DOYLE.

357. **Safety Engineering.** The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. I, II; ½ to ¾ unit. HARPER.

358. **Problems in Safety Engineering.** Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles and applications for the student interested in entering the field of safety engineering in industry. II; ½ to ¾ unit. Prerequisite: Industrial Engineering 235 or 357; consent of instructor. HARPER.

359. **Industrial Fire Protection.** Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. II; ½ to ¾ unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. HARPER.

MINING AND METALLURGICAL ENGINEERING

The Department of Mining and Metallurgical Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. The prerequisite for graduate work with metallurgical engineering or mining engineering as a major is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in the major field of study at the University of Illinois. A student who is deficient in background and previous training may be required to register in certain undergraduate courses (without graduate credit) as a prerequisite to graduate work. At the end of the student's first registration his adviser enters on a "Memorandum of Prerequisites" the undergraduate courses necessary for the student to complete. The departmental scholastic requirements for admission to graduate study on full standing, advanced standing, and limited status are given on page 15.

A candidate for the degree of Master of Science is ordinarily required to have a minimum of eight units of graduate work, including a thesis. However, a degree is not granted for this minimum if a student receives one unit of C unless he also receives one unit of A, or to one who receives more than one unit of C. Additional work is required of a student who does not meet this standard.

If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. The thesis requirement is not waived for research assistants, or, in general, for assistants on research projects.

In the case of candidacy for the degree of Doctor of Philosophy, the thesis subject, approved by the adviser, must be announced at or before the beginning of the third year of study. The student must choose an acceptable subject for his thesis before he can take the preliminary examination.

Before a candidate is admitted to the oral preliminary examination, he is required to pass a series of written preliminary examinations given several weeks in advance of the oral preliminary examination. The examinations need not be based on formal course work alone, but are intended to determine the student's knowledge of his entire field including his knowledge of previous work, history, and practice in his field of specialization.

A candidate for the degree of Doctor of Philosophy is required to pursue a major in the subject in which his research lies. He is also required to choose one or two minor subjects. If one minor only is chosen it must be taken in a department of study other than that of the major, and credit for it may be earned by work representing not less than four units (a total of twenty-four units of graduate work is required for the doctorate). If two minors are chosen, one must be closely related to the major, and the second minor (not less than two units) must be taken in a department of study other than that of the major or first minor. Acceptable minors, unless special permission is granted by petition, are from the following subjects: physical chemistry, analytical chemistry, geology, mathematics, theoretical and applied mechanics, and physics.

The department publishes a brochure entitled "Graduate Study and Research in Mining and Metallurgical Engineering" which gives further details about departmental requirements for graduate study. Copies may be secured by addressing the head of the Department of Mining and Metallurgical Engineering, 311 Ceramics Building.

FELLOWSHIPS AND ASSISTANTSHIPS

A number of graduate fellowships in mining engineering have been established by the Sahara Coal Company. One or more are awarded each year on recommendation of the Department of Mining and Metallurgical Engineering. They are for one to three years of graduate study and research in coal-mining engineering. The stipend is $1,500.

The Union Carbide and Carbon Research Laboratories Fellowship, with an annual stipend of $1,400 to $2,100 (depending upon marital status and previous experience), is awarded to second- and third-year graduate students in metallurgical engineering.

One fellowship is offered annually by Olin Industries, Inc., to a second- or third-year graduate student in metallurgical engineering for research in titanium and its alloys. It is awarded with a stipend of $850 for second year and $1,000 for third year of study, on recommendation of the head of the Department of Mining and Metallurgical Engineering.

A number of research assistantships on half-time basis are available to graduate students in mining or metallurgical engineering. The stipend is $1,500 for a school year of two semesters, and exemption from tuition, laboratory, library, and supply fees. A half-time assistant may carry up to three units of graduate work each semester. It is usually possible to assign an assistant to duties in the field of his special interest. Inquiries concerning these positions should be directed to the head of the department, 311 Ceramics Building.

GRADUATE TEACHING FACULTY

Professors: T. A. Read (Head of Department), P. A. Beck, W. R. Chedsey (*Emeritus*), W. H. Voskuil, C. A. Wert, F. D. Wright.
Associate Professors: R. W. Balluffi, W. H. Bruckner, E. J. Eckel, A. C. Forsyth, B. G. Ricketts, W. D. Rose. R. G. Wuerker.
Assistant Professors: R. W. Bohl, D. S. Lieberman, M. Metzger.

Mining Engineering

COURSES FOR GRADUATES

401. **Advanced Mineral Dressing and Coal Preparation.** Advanced theory and practice of mineral dressing and coal preparation processes. I or II; 1 unit. Wuerker.

402. **Mine Valuation, Taxation, and Mineral Economics.** A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. I or II; 1 unit.

403. **Advanced Mine Administration.** Current methods and systems of mine administration in use by major mining corporations. I or II; 1 unit.

405. **Advanced Mine Ventilation.** Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. I; 1 unit.

406. **Design of Underground Mines.** Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. II; 1 unit. Prerequisite: Mining Engineering 253 or equivalent. Wright.

491. **Research in Mining Engineering and Mineral Dressing.** Individual research in some phase of the general field of mining engineering under the supervision of members of the staff. Results of research may be used for graduate thesis. I, II; ½ to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **World Mineral Economics.** The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. II; ¾ to 1 unit. VOSKUIL.

304. **Mine Safety Engineering.** A detailed study of mine accident statistics, causes of accidents, accident prevention; calculation of insurance rates and cost of mine accidents; psychology of accident prevention; state and federal mining laws as related to safety. I; ¾ unit. Prerequisite: Mining Engineering 253.

351. **Geophysical Prospecting.** Same as Geology 351. Principles of geophysics and their application to mining processes. I; 1 unit. WUERKER.

354. **Mining Geology.** Same as Geology 354. Structure and occurrence of mineral deposits in relation to prospecting, exploration, development and exploitation. II; 1 unit. Prerequisite: Geology 101 or 150, 130 or 131, and Mining Engineering 201 or 230; or consent of instructor. WRIGHT.

358. **Engineering Properties of Rocks.** Strength and elastic properties of rocks, their determination and utilization in comminution, roof control, and fracturing of wells. Discussion of tests in free and confined state. Applications to mineral engineering processes, such as drilling and blasting. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or consent of instructor. WUERKER.

371. **Petroleum Production Engineering.** Field development. Properties of petroleum, oil reservoirs, exploration and drilling methods, casing methods, and well logging. I; ½ to ¾ unit. Prerequisite: Consent of instructor.

372. **Petroleum Production Engineering.** Study of reservoir performance, principle of oil and gas recovery, storage and transportation, and economics of oil field exploitation. II; ½ to ¾ unit. Prerequisite: Mining Engineering 371.

373. **Advanced Reservoir Engineering.** Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. I; ¾ to 1 unit. Prerequisite: Mining Engineering 372 or consent of instructor; Mathematics 345. ROSE.

374. **Recovery of Petroleum.** An introduction to the various methods of petroleum recovery from underground reservoirs, especially emphasizing secondary recovery methods. II; ¾ to 1 unit. Prerequisite: Mining Engineering 372 or consent of instructor. ROSE.

375. **Advanced Petroleum Engineering Laboratory.** Techniques of petroleum engineering research to evaluate the effectiveness of various methods for drilling and completing wells and for recovering petroleum from underground reservoirs. I, II; ¾ unit. Prerequisite: Mining Engineering 372 or consent of instructor. ROSE.

396. **Seminar.** Review of mining literature; reports; technical writing. II; ¼ unit. STAFF.

Metallurgical Engineering

COURSES FOR GRADUATES

401. **Advanced Physical Metallurgy.** Interpretation and experimental determination of multielement phase diagrams with the emphasis on ternary systems. I or II; 1 unit. Prerequisite: Equivalent of the undergraduate courses required in metallurgical engineering. ECKEL.

402. **Advanced Metallographic Technique.** Advanced study of metallographic laboratory procedure. Special purpose laboratory techniques. I; 1 unit. RICKETTS.

405. **Advanced Physics of Metals.** Elementary concepts of quantum mechanics; the structure of the atom; assemblies of atoms. I; 1 unit. Prerequisite: Consent of instructor. WERT.

406. **Advanced Physics of Metals.** The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. II; 1 unit. Prerequisite: Metallurgical Engineering 405. WERT.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. I; 1 unit. Prerequisite: Consent of instructor. BECK.

410. **Advanced X-ray Metallography.** X-ray diffraction techniques as applied to the study of metals; cold work and annealing; ordering and clustering in solid solutions; phase transformations; sub-grain structures. Studies of metals by electron and neutron diffraction. II; 1 unit. Prerequisite: Chemistry 427 or consent of instructor. LIEBERMAN.

491. **Research in Metallurgy.** Individual research in specialized problems under the supervision of members of the staff. Results of research may be used for graduate thesis. I, II; ½ to 4 units. STAFF.

493. **Seminar on Anelasticity.** Lectures and discussions of the nature of anelasticity and its application to metallurgy. I, II; ¼ unit. Prerequisite: Consent of instructor. WERT.

494. **Seminar on Phase Transformations in Metals.** Discussion of current research in this field including presentation by graduate students of their own work. I, II; ¼ unit. Prerequisite: Consent of instructor. LIEBERMAN, READ.

495. **Seminar on Diffusion and Imperfections.** Lectures and discussions on diffusion and imperfections in crystalline solids. I, II; ¼ unit. Prerequisite: Consent of instructor. BALLUFFI.

497. **Seminar on Recrystallization and Theory of Alloys.** Graduate students present the results of their own research work and the results of recently published research by other investigators principally in the fields of recovery, subgrains, recrystallization, grain growth, textures, and alloys of the transition elements. I, II; ¼ unit. BECK.

498. **Colloquium in Physical Metallurgy.** Review of current metallurgical research in other laboratories by visiting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. I, II; no credit.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Metallurgy of Welding.** A survey is made of existing welding procedures and their metallurgical (ferrous and non-ferrous) consequences with respect to the weld and base metal involved thermally in the welding operations. Heat flow in metals, arc behavior, slag behavior, and the physical metallurgy of heat-affected base metal are considered. Engineering phases of welding covered are economics of welding in relation to other methods of joining metals or producing engineering structures, thermal stresses, specification of materials for weld and base metal, and methods of production by means of welding and gas cutting. I or II; ¾ to 1 unit. Prerequisite: Metallurgical Engineering 208 and 210 or consent of instructor. BRUCKNER.

302. Powder Metallurgy. Production of powder metals; fabrication of metal shapes from powder metals; compacting, sintering, testing, and application of powdered metal shapes. II; ½ or ¾ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 304. ECKEL.

304. Powder Metallurgy Laboratory. Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. II; ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302. ECKEL.

305. Metallurgy of Steel Castings. Technical and metallurgical control in the production of steel castings; acid and basic furnace practices; control of slag in steel making; heat treatment and metallography of steel castings. I or II; ¾ or 1 unit. Prerequisite: Metallurgical Engineering 205, 208, and 210. FORSYTH.

308. Metallurgical Thermodynamics. Fundamental thermodynamic considerations and application of thermodynamics to metallurgical problems. Particular emphasis on heterogeneous equilibria and thermodynamics of solutions. I; ¾ to 1 unit. Prerequisite: Chemistry 246. BALLUFFI.

309. The Anisotropic Properties of Crystals. The anisotropic properties of metal crystals are studied. Emphasis is placed upon electrical and thermal conductivity, piezo-electricity and elasticity. The effect of crystal symmetry on these properties is studied for all common crystal types. I; 1 unit. Prerequisite: Consent of instructor. WERT.

310. Kinetics of Phase Changes in Metals. Characteristics of phase changes in solids; phenomenological analysis of nucleation and growth; the roles of diffusion, interfacial energy and strain energy; attempts at quantitative treatment of crystallization, eutectoid decomposition, diffusionless phase changes, and precipitation. II; 1 unit. Prerequisite: Consent of instructor. METZGER.

318. Introduction to Metal Physics. The free electron theory of metals, thermal and electrical conductivities, specific heat, thermo-electric effects, the Hall effect, motions of electrons in a periodic field, the band approximation, semiconductors and transistors, cohesion, ferro-magnetism, thermionic emission; the structure of alloy phases, diffusion in metals, order-disorder, phase precipitation by nucleation and growth. I; ¾ unit. Prerequisite: Chemistry 246, Metallurgical Engineering 209, or consent of instructor.

MUSIC

The School of Music offers the degrees of Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Degree of Master of Music. For the degree of Master of Music, the major field may be in musicology, music theory and composition, applied music (organ, voice, piano, violin, viola, cello, solo wind instruments), or band and orchestra instruments.

The admission requirement, in terms of grade-point average, is at least 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

In addition, an applicant for admission to graduate study in music is required (1) to have finished successfully a four-year undergraduate curriculum in music

or music education, or its equivalent in hours and content, from an institution which holds membership in the Association of American Universities, or from a liberal arts college recognized by the North Central Association or equivalent regional accrediting association, or from an independent conservatory or school of music whose four-year undergraduate curricula represent the equivalent in hours, content, and attainment of those offered at the University of Illinois; and (2) to pass a qualifying examination in the major field of concentration to be administered by the graduate committee of the School of Music. If the major is to be applied music or band and orchestra conducting, this examination is essentially one of performance on the major instrument and is given at specified times during the year. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of both German and French is desirable. Each applicant must furnish the graduate committee of the School of Music a copy of his official undergraduate transcript.

Degree of Doctor of Musical Arts. The degree of Doctor of Musical Arts is offered to candidates who are capable of demonstrating that kind of professional competence and artistic independence which results when technical skills and musical talent are supported by a thorough and comprehensive grasp of musical theory, of the history of the musical literature, of the evolution of styles and performance practices, and of the broad spiritual and aesthetic principles which underlie all artistic manifestations. The fields of specialization for the degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree is available to candidates with a major in one of the following fields: composition, piano, organ, violin, cello, and voice.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to the program leading to the degree of Doctor of Musical Arts. The prerequisites for admission are as follows:

(1) The degree of Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent):

(a) Major in Composition: advanced composition, two units; theory, two units; Music 428, Problems and Methods, one unit; electives, three units;

(b) Major in Applied Music: applied music, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) Composition or performance honors awarded to the student on the basis of a program presented in connection with his work toward the master's degree.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) Superior work in Music 428 or its equivalent.

(5) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature, psychology, and philosophy. Students lacking an appropriate background in liberal arts and sciences when applying for admission to the program may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination. The graduate committee of the School of Music reserves the right to require a student to reinforce his preparation in areas which are relevant to his program of study by the successful completion of additional courses in the liberal arts and sciences.

(6) The successful completion of examinations administered by the graduate committee of the School of Music. These examinations include applied music,

theory of music, history of music, and a verbal competence test. An unsatisfactory showing in any of these areas by a student who meets other prerequisites may lead to an acceptance of the student provisionally, but such students are expected to pass these examinations by the end of the first semester of their matriculation in this program (calculated on a full-time residence basis).

After admission to the doctoral program the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, calendar, grades, and major and minor fields.

A minimum of sixteen units of graduate credit beyond the eight units required for the degree of Master of Music is necessary to earn the degree of Doctor of Musical Arts. Of this total, three units are devoted to the completion of a special doctoral project involving the following: for the student majoring in composition, the writing of a representative original score on a large scale; for the student majoring in applied music, the study of a comprehensive repertoire and the presentation of two full-length recital programs including solo and, where appropriate, chamber music works. Two units are devoted to the completion of an original thesis.

In addition to the foregoing, the work includes the following required courses: composition or applied music, three units; Music 420, Seminar in Music Literature for Doctoral Candidates, two units. One unit of work must be taken in the field of education or music education. At least two, but no more than four, units are devoted to an outside minor field. The outside minor field may be history, philosophy, psychology, related arts, English or other literature, sociology, acoustics, journalism, or education. Other minor fields may be accepted upon recommendation of the major adviser.

Of the six units of elective credit available within the total program, including the work toward the master's degree, at least three must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must complete the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College. For eligibility the student must (1) have completed a minimum of eight units of work beyond the master's degree including two units in composition or applied music, two units in Music 420, Seminar in Music Literature, one unit in education or music education, and one unit of the outside minor field; (2) have passed the required language examinations, of which one is in German and one in French, Italian, Spanish, or Russian as designated by the graduate committee, and also in one or more additional foreign languages where, in the opinion of the graduate committee, the knowledge of such language is necessary for proper research in the student's field of concentration; and (3) have received the recommendation of his adviser.

The work to be covered in the final year of study (calculated on a full-time residence basis) is as follows: applied music or composition, one unit; doctoral project, three units; thesis, two units; electives, two units.

After completion of the doctoral project, the thesis, and the remaining course work, and upon recommendation of the graduate committee, the candidate is eligible for his final examination which must be held at least two weeks prior to the date when the degree is conferred. This examination is on the original score or, respectively, on the repertoire numbers, and on the thesis prepared by the candidate, but also covers broader aspects of the general field of music literature, history, and theory. It is conducted by a committee appointed by the Dean of the Graduate College.

Degree of Doctor of Philosophy in Musicology. The degree of Doctor of Philosophy in Musicology is offered in such fields of music as merit and demand research methods. It is intended for applicants whose interest lies in research in

the history of music, theory of music, psychology of music, comparative musicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College (see page 15), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to the program leading to the degree of Doctor of Philosophy. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the degree of Master of Music with a major in musicology or theory of music; (2) have acquired an adequate background in those areas of the liberal arts and sciences relevant to his studies; (3) have promise of superior ability and outstanding achievement, qualities commonly expressed by an average of higher than 4.25 in the student's previous graduate work, though other indications are evaluated; but in no case is admission to the doctoral program granted to a student who has maintained a graduate average of less than 4.0, or who has had the equivalent of two units of work below B in his previous graduate study; (4) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music, including examinations in applied music, theory of music, and history of music. An unsatisfactory showing in any one of these examinations by an applicant who meets other prerequisites may lead to provisional acceptance, but such students are expected to pass all examinations during their first year of work.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the minimum of twenty-four units of graduate credit necessary to earn the degree of Doctor of Philosophy must be in Music 429 and are devoted to the completion of an original doctoral thesis subsequent to the official admission of the student to candidacy. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or their equivalent, in courses including Music 314, 320, 322, 414, 415, 422, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in applied music. Credit for units not in music is granted toward the Doctor of Philosophy degree only where approved by the graduate committee as relevant to the student's field of specialization.

(2) A minimum of two units each in one or two of the following minor fields: history, philosophy, psychology, related arts, English or other literature, sociology, classics, anthropology, physics (acoustics), electrical engineering, journalism, or education. Other minor fields may be accepted upon recommendation of the major adviser.

(3) In addition to the general foreign language requirements of the Graduate College, an examination in one or more additional foreign languages when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(4) A preliminary examination administered by a committee appointed by the Dean of the Graduate College. This examination consists of a written examination on the history of music; a written examination in the area of the student's field of concentration; the submission, at least a month prior to the written examinations, of a score of a free composition, a fugue, or an instrumentation project, of a nature approved by the graduate committee of the School of Music; and an oral examination on the general field of musicology and on the content of the written examinations.

Degree of Master of Science in Music Education. Candidates for the degree of Master of Science in Music Education must earn four units in music,

three and one-half of which are electives, two units in education, and two units in electives. Requirements are music electives, four units; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives must be selected with the approval of the adviser. Three electives must be in music, and the other two in music, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the department. All applicants for admission are required to satisfy a qualifying examination of performance in the principal applied music area. Students are not admitted to this program on limited status.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the degree of Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have maintained a 4.0 average in all previous graduate work. He must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music theory and applied music to determine the candidate's level of proficiency in those areas. A candidate whose level of proficiency is below that required by the University of Illinois for the Bachelor of Science degree in Music Education is required to take work in addition to the course work prescribed below under "Program."

Residence. The minimum residence requirement is one semester during which a minimum of three units is successfully completed, or two summer sessions during each of which a minimum of two units is successfully completed. All work for the certificate may be completed in summer sessions.

Program. A minimum of eight units of course work beyond the master's degree is required. All of the course work must be taken on the Urbana campus of the University. Music 440 and 441 and either Education 411 or 412 are required. The remainder of the program is based upon the student's needs and interests and upon the deficiencies revealed in placement tests. No more than one unit of applied music may be counted toward the certificate. With the prior approval of an adviser, courses in music which carry undergraduate numbers may be approved for credit. Such credit is computed at the rate of one-fourth unit for each semester hour of credit. No such credit can be counted toward the requirements of the degrees of Master of Science in Music Education and Doctor of Education with a major in music education.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Degree of Doctor of Education. The program leading to the degree of Doctor of Education with a major in music education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations administered by the School of Music include music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in music courses and six units of credit in education courses. No more than one unit of credit in applied music may be counted toward the degree. Students found deficient in applied music are expected to correct the deficiency in addition to the prescribed course work.

The following courses are required: Education 410, 415, Music 440, 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. Extramural course work may not be included as part of this sixteen-unit requirement. A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the degree of Doctor of Education with a music education major. A student may, with the approval of the advisers, plan a maximum of four units of work to be accomplished at other accredited institutions. No more than six units of credit earned at other universities may be included in the minimum sixteen-unit requirement.

A preliminary examination in music and education must be completed prior to the beginning of the dissertation. A student who has completed a minimum of eight units of course work subsequent to his admission may take the preliminary examination when it is recommended by his advisers. The preliminary examination is given by a committee composed of representatives from the School of Music and the College of Education appointed by the Dean of the Graduate College. The nature of the examination is determined by the committee. Part of the examination may be written. Part of it must be oral. Prior to admission to the preliminary examination the student is expected to demonstrate broad competence in professional education and in music and music education. Competence may be demonstrated by a grade of B or better in appropriate courses or by satisfactory completion of proficiency examinations.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

A final oral examination is held at least two weeks prior to the date the degree is conferred. The examination committee is appointed by the Dean of the Graduate College and should include representatives from both the School of Music and the College of Education. The final examination is primarily concerned with a report of the thesis study, but also extends over the whole field of the candidate's study.

Upon satisfactory completion of all degree requirements in both the School of Music and the College of Education, the candidates are recommended for graduation by the School of Music.

GRADUATE TEACHING FACULTY

Professors: D. A. Branigan (Director of the School of Music), B. Bergethon, S. Fletcher, B. R. Foote, S. Goldthwaite, B. Goodman, M. H. Hindsley, H. Kessler, J. M. Kuypers, R. H. Miles, B. Phillips, D. Plamenac, P. Rolland, S. Schoonmaker, S. Stravinsky, G. Waller, Jane C. Watt, P. Young.

Associate Professors: J. R. Battista (Visiting), G. W. Binkerd, Dorothy E. Bowen, Beth Bradley, J. C. Garvey, L. R. Hamp, K. Kellogg, J. R. Kelly, E. D. Kisinger, C. Leonhard, P. Painter, P. S. Pettinga, Claire L. Richards, W. L. Roosa, H. C. Schmitt, H. O. Sexton, R. H. Swenson, E. H. Weigel, Grace Wilson, Velma K. Wilson, L. E. Zirner.

Assistant Professors: J. Allen, A. M. Carter, Dorothy E. Clark, G. Hunter, Colleen J. Kirk, D. A. Ledet, A. J. McDowell, W. Miller, C. V. Palisca, P. W. Price, W. G. Reeves.

Instructors: J. L. Bailey, E. S. Berry, W. Coggins, C. O. DeLaney, P. Farrell, R. E. Gray, T. L. Holden, E. Krolick.

COURSES FOR GRADUATES

400. Advanced Instrumentation: Chamber and Symphonic. Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. I; ½ to 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. Advanced Instrumentation: Band. Arrange for the concert band works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. II; ½ to 1 unit. Prerequisite: Undergraduate instrumentation. Hindsley.

402. Analysis in Relation to Performance and Interpretation, I. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. I; 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. Leonhard.

403. Analysis in Relation to Performance and Interpretation, II. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. II; 1 unit. Prerequisite: Music 402. Leonhard.

406. Composition. Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. I, II; ½ to 1½ units. Staff.

410. History of Music Theory, I. A study of selected theoretical treatises written before 1400. I; ½ to 1 unit. Offered in 1956-1957 and in alternate years.

411. History of Music Theory, II. A study of selected theoretical treatises written after 1400. II; ½ unit. Offered in 1956-1957 and in alternate years.

412. History of Musical Aesthetics, I. A survey of the principal philosophies of music, their historical backgrounds and their relation to musical styles. From Pythagoreanism to the humanistic period. I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Graduate standing in music. Palisca.

413. History of Musical Aesthetics, II. A survey of the principal philosophies of music, their historical backgrounds and their relation to musical styles. From the seventeenth century to the present day. II; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Music 412. Palisca.

414. **Notation, I.** The history of notation from its beginning to 1400. I; ½ unit. Prerequisite: Consent of instructor. PLAMENAC.

415. **Notation, II.** The history of notation from 1400 to 1600, including instrumental tablatures. II; ½ unit. Prerequisite: Music 414 or consent of instructor. PLAMENAC.

416. **History of Instrumental Music to 1600.** A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. I; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Music 312. GOLDTHWAITE.

417. **History of Instrumental Music from 1600 to 1750.** A study of instrumental music in the Baroque era. II; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Music 416 or consent of instructor. GOLDTHWAITE.

418. **The Origins and the History of Opera up to Gluck.** The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory and aesthetics of opera. The principal composers covered are Monteverdi, Cavalli, Cesti, Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. I; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Music 312. PALISCA.

420. **Seminar in Music Literature.** Intensive study of outstanding works selected from all fields of music literature. Required of all students enrolled in the Doctor of Musical Arts program. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. GOLDTHWAITE.

421. **Seminar in Music Education.** Designed to introduce graduate students in music education to the methods of research and the planning of professional projects. The work includes lectures, critical analysis of professional projects, and the presentation of preliminary reports on student projects. I, II; 1 unit. BERGETHON.

422. **Seminar in Theory of Music.** Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. I, II; ½ or 1 unit. KESSLER.

423. **Seminar in Musicology.** Problems in historical and systematic musicology. Discussions of special problems and reports on individual research. I, II; 1 unit. PLAMENAC.

424. **Bach, I.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. I; ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music degree. MILES.

425. **Bach, II.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. II; ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music degree. MILES.

426. **Beethoven, I.** I; ½ or 1 unit. Offered in 1957-1958 and in alternate years. KUYPERS.

427. **Beethoven, II.** II; ½ or 1 unit. Offered in 1957-1958 and in alternate years. KUYPERS.

428. **Problems and Methods.** An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports on bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. I, II; 1 unit. PALISCA.

429. **Thesis and Research.** I, II; ½ to 4 units. STAFF.

430. **Advanced Orchestra Conducting and Literature.** II; 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. BERGETHON, GOODMAN.

431. **Advanced Band Conducting and Literature.** I; 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Conducting, Literature, and Administration.** Deals with the training and conducting of choral groups, including musical and organizational problems. I or II; 1 unit. KIRK.

433. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. I; 1 unit. Prerequisite: Bachelor's degree with major experience in band and/or orchestra. KISINGER.

434. **Piano Literature.** I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. KESSLER.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. I, II; 1 unit; Maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. KELLOGG, REEVES.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. MILES.

437. **String Instrument Literature.** I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. ROOSA.

438. **Wind Instrument Literature.** An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance when possible, of the music itself, recordings, and collateral readings. I, II; 1 unit; maximum accumulated credit, 2 units. KISINGER, LEDET.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. I; ½ unit. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. II; ½ unit. LEONHARD.

442. **The General Music Program in Secondary Schools.** A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. I or II; ½ unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. **Administration and Supervision of Music Education.** II; ½ unit. Prerequisite: Bachelor of Science degree in music education or in education with a music major, or Bachelor of Music degree, including music education courses. BERGETHON.

444. **Audio-Visual and Scientific Aids in Music Education.** A survey of audio-visual equipment and materials with emphasis upon applications to music

education. Special emphasis is given to the development of new techniques and uses of audio-visual aids in the teaching and study of music. Research studies in this field are examined, and the need for further research is emphasized. I; 1 unit. Prerequisite: Consent of instructor.

445. **Music in Higher Education.** An orientation to the organization, teaching, and administration of music in the college and university. I or II; ½ unit. Prerequisite: Graduate standing in music education. BERGETHON.

480. **Piano.** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

481. **Voice.** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

482. **Organ.** Selected studies from the masterworks of organ literature. I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

483. **Violin.** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

484. **Cello.** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Counterpoint, I.** Creative writing in linear counterpoint of the following: rounds, instrumental and vocal; canons; inventions; and fugues. Analysis of Bach *Inventions* and the *Well-Tempered Clavier.* I; ½ unit. Prerequisite: Music 104. KELLY, WEIGEL.

301. **Advanced Counterpoint, II.** Creative writing in linear counterpoint of the following: rounds, instrumental and vocal; canons; inventions; and fugues. Analysis of Bach *Inventions* and the *Well-Tempered Clavier.* II; ½ unit. Prerequisite: Music 300. KELLY, WEIGEL.

302. **Fugue, I.** Systematic practice in writing the various parts of the fugue, together with analysis of fugues by Bach and Handel. I; ½ unit. Prerequisite: Music 104 and/or consent of instructor. FARRELL, HUNTER, KELLY.

303. **Fugue, II.** Continuation of Music 302, including the writing of complete fugues and analysis of fugal composition of the nineteenth and twentieth centuries. II; ½ unit. Prerequisite: Music 302 and/or consent of instructor. FARRELL, HUNTER, KELLY.

304. **Analytical Techniques, I.** Examination of music from plain song and the earliest polyphony to the close of the sixteenth century. Emphasis is placed upon penetration of the compositional techniques used and includes the study of form and harmony as these bear on the problems. I; ½ unit. Prerequisite: Music 104 or consent of instructor. PHILLIPS.

305. **Analytical Techniques, II.** Continuation of Music 304, beginning with the early seventeenth century and coming down to the present day. II; ½ unit. Prerequisite: Music 304 or consent of instructor. PHILLIPS.

306. **Composition.** Work in original composition including the small and large homophonic forms. I, II; ½ or 1 unit. Prerequisite: Music 104 or 106 or consent of instructor. STAFF.

307. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. Through study and singing, seeks familiarization with the styles of Dunstable, Dufay, Obrecht, Okeghem, Gombert, DesPres, Lassus, and Palestrina. Writing is based on results of the study of these composers' works. I; ½ unit. Prerequisite: Consent of instructor. BINKERD.

308. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Continuation of Music 307. II; ½ unit. Prerequisite: Music 307. BINKERD.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. I; ½ unit. Prerequisite: Music 112. PALISCA.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. II; ½ unit. Prerequisite: Music 310. PALISCA.

312. **Music of the Baroque and Classical Periods.** A history of music from about 1600 to 1800. I; ½ unit. Prerequisite: Music 311. ROOSA.

313. **Music of the Nineteenth and Twentieth Centuries.** A history of music from about 1800 to the present. II; ½ unit. Prerequisite: Music 312. ROOSA.

314. **History of Performance Practices.** Study of the history of performance practices including the preparation of appropriate historical material for performance. I, II; ½ unit. HUNTER.

315. **Contemporary Music.** A survey of all important trends, forms, and styles of modern music from 1875 to the present. I, II; ½ unit. Prerequisite: Consent of instructor. KUYPERS.

320. **Proseminar.** Provides special preparation in the specialized fields of musicology, theory, and composition. I, II; ½ unit; maximum credit, 1 unit. Prerequisite: Consent of instructor. GOLDTHWAITE and staff.

321. **Music Bibliography and Reference.** Detailed study of the basic and most useful reference and bibliographic aids. Practice problems in the use of specific titles and in how to find materials in the library are given. Music, books about music, and recordings of music are included. I or II; ½ unit. ALLEN.

322. **Introduction to Musicology.** A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. I, II; ½ unit. PLAMENAC.

330. **Applied Music Pedagogy.** Survey of techniques, practices, and materials. Presentation of group and individual instruction. An approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. I, II; ½ unit. BRADLEY, FLETCHER, ROLLAND.

332. **Church Music Literature.** Survey of the development of church music with emphasis on the period since 1500. I; ½ unit. Prerequisite: Music 214 or 311, or consent of instructor. PETTINGA.

333. **Church Music Techniques.** The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. II; ½ unit. Prerequisite: Music 332 or consent of instructor. PETTINGA.

[illegible]2. **Percussion Methods.** Designed primarily for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. I or II; ½ unit.

[illegible]4. **Methods of String Class Teaching.** Designed primarily for teachers of school music who are not performers on a string instrument yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Consent of instructor. WALLER.

[illegible]5. **Teaching Techniques of Music Theory.** Techniques and materials used in the teaching of theory of music in senior high school and junior college. I; ½ unit. Prerequisite: Music 300 or consent of instructor. CARTER.

[illegible]6. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools.

S; ½ or 1 unit. Prerequisite: One year of teaching experience or consent of instructor. BERGETHON, LEONHARD.

347. **Teaching of Woodwind Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1956 and in alternate years. MCDOWELL.

348. **Teaching of Brass Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1957 and in alternate years. SEXTON.

350. **Advanced Chamber Music.** Selected projects in chamber music on the advanced level for qualified students. I, II; ½ unit. Prerequisite: Applied music on the 300 level and consent of instructor. GARVEY and staff.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

380. **Piano.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BATTISTA, BRADLEY, FLETCHER, RICHARDS, SCHOONMAKER, STRAVINSKY, WATT, ZIRNER.

381. **Voice.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BAILEY, BOWEN, CLARK, FOOTE, HAMP, KELLOGG, MILLER, WILSON.

382. **Organ.** I, II; ½ or 1 unit. S; ¼ or ½ unit. MILES, PETTINGA.

383. **Violin.** I, II; ½ or 1 unit. S; ¼ or ½ unit. ROLLAND, SCHMITT.

384. **Viola.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GARVEY.

385. **Cello.** I, II; ½ or 1 unit. S; ¼ or ½ unit. FARRELL, SWENSON.

386. **String Bass.** I, II; ½ or 1 unit. S; ¼ or ½ unit. KROLICK.

387. **Flute.** I, II; ½ or 1 unit. S; ¼ or ½ unit. DELANEY.

388. **Clarinet.** I, II; ½ or 1 unit. S; ¼ or ½ unit. MCDOWELL.

389. **Oboe.** I, II; ½ or 1 unit. S; ¼ or ½ unit. LEDET.

390. **Bassoon.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BERRY.

391. **Cornet and Trumpet.** I, II; ½ or 1 unit. S; ¼ or ½ unit. SEXTON.

392. **French Horn.** I, II; ½ or 1 unit. S; ¼ or ½ unit. HOLDEN.

393. **Trombone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GRAY.

394. **Baritone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GRAY.

395. **Tuba.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GRAY.

396. **Percussion.** I, II; ½ or 1 unit. S; ¼ or ½ unit. PRICE.

397. **Harp.** I, II; ½ or 1 unit. S; ¼ or ½ unit. RENSCH.

398. **Saxophone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. COGGINS.

399. **Harpsichord.** I, II; ½ or 1 unit. S; ¼ or ½ unit. HUNTER.

PHILOSOPHY

The Department of Philosophy offers graduate work leading to the Master of Arts and Doctor of Philosophy degrees.

Students undertaking graduate work with philosophy as their major subject must have had a grade-point average of at least 3.5 for that portion of the work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training.

In addition, students majoring in philosophy should have had a course in logic, a course in ethics, and a general course in the history of philosophy. Students with deficiencies are required to fill them by taking Philosophy 102 (or 333), 321, or 303-306, respectively, in addition to the minimum requirement of eight units for the master's degree.

Degree of Master of Arts. A candidate for this degree must choose at least one course in each of the following three fields: history of philosophy; theory of knowledge, including logic and philosophy of science; and theory of value, including ethics and esthetics. In addition to completing eight units of graduate work, the candidate must take an oral examination on the work represented by these units. His adviser arranges and presides at this examination. Applications to have the thesis requirement waived are not approved except on recommendation of the adviser and vote of the department.

Degree of Doctor of Philosophy. A candidate for this degree carries on (1) major studies in one of the three fields within the department; (2) minor studies amounting to at least two units in each of the two remaining fields; and (3) minor studies amounting to at least two units in a department other than philosophy. The three fields within the Department of Philosophy are history of philosophy; theory of knowledge, including logic and philosophy of science; and theory of value, including ethics, social philosophy, and esthetics. The candidate's choice of major and minors must be approved by the department.

The preliminary examination for the doctor's degree, in addition to the major and minor subjects, presupposes first-hand acquaintance with at least one major work of Plato, Aristotle, Augustine or Aquinas, Descartes, Spinoza, Leibniz, Locke, Berkeley, Hume, Kant, and Hegel.

The details of the special departmental requirements for graduate degrees can be obtained in mimeographed form by addressing a request to the Department of Philosophy, 119 Lincoln Hall.

ASSISTANTSHIPS

The department has available each year a limited number of half-time and quarter-time teaching assistantships for properly qualified graduate students. Applications should be sent directly to the department, 119 Lincoln Hall, not later than March 1 of the scholastic year preceding that for which application is made.

GRADUATE TEACHING FACULTY

Professors: D. W. Gotshalk (Chairman of Department), A. Church (Visiting), M. H. Fisch, A. R. Turquette, F. L. Will.
Associate Professor: B. J. Diggs.
Assistant Professors: O. A. Kubitz, L. Linsky, H. M. Tiebout.
Instructors: P. Diesing, D. Shwayder.

COURSES FOR GRADUATES

401. Seminar in Ancient Philosophy. I; 1 unit.

402. Seminar in Ancient Philosophy. II; 1 unit. Fisch.

403. Seminar in Medieval Philosophy. I or II; 1 unit. Diggs.

405. Seventeenth Century Continental Thought (Descartes, Spinoza, Leibniz). A study of the basic philosophical works of the three leading continental thinkers of the century. I or II; 1 unit. Gotshalk.

407. British Empiricism. I or II; 1 unit. Turquette.

408. **German Idealism (Kant).** I or II; 1 unit. GOTSHALK.

409. **Recent American Philosophy.** Major American philosophers and movements since about 1900. Reports and discussions. I or II; 1 unit. FISCH.

411. **Seminar in Recent Ethical Theory.** I or II; 1 unit. DIGGS, FISCH.

412. **Seminar in Social Philosophy.** A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. Students may receive credit more than once. I or II; 1 unit. DIGGS.

413. **Logical Theory.** I or II; 1 unit. Prerequisite: A course in logic or consent of instructor. TURQUETTE.

414. **Logical Foundations of Mathematics.** Same as Mathematics 414. II (1956-1957 only); 1 unit. Prerequisite: A course in symbolic logic or consent of instructor.

420. **Seminar in Semantics.** Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. I or II; 1 unit. LINSKY.

421. **Seminar in Contemporary Problems.** Intensive study of selected problems on topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. I or II; 1 unit. WILL.

422. **Seminar in Contemporary Problems.** Intensive study of selected problems on topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. I or II; 1 unit. FISCH, WILL.

423. **Seminar in Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. I; 1 unit. WILL.

424. **Seminar in Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. II; 1 unit. WILL.

430. **Seminar in Modern Aesthetics.** I or II; 1 unit. GOTSHALK.

493. **Research.** Research in special topics. I, II; ½ to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **History of Greek and Roman Philosophy.** I; ½ to 1 unit. FISCH.

304. **History of Medieval Philosophy.** Lectures and readings in the history of philosophy from St. Augustine to William of Ockham. II; ½ to 1 unit. Prerequisite: Philosophy 101 or 303, or consent of instructor. DIGGS.

306. **History of Modern Philosophy.** II; ½ to 1 unit. GOTSHALK.

309. **The Philosophy of Plato.** I; ½ to 1 unit. Prerequisite: Philosophy 101 or 303.

311. **Philosophic Ideas of the Nineteenth and Twentieth Centuries.** I, II; ½ to 1 unit. FISCH, TIEBOUT.

313. **American Philosophy.** The history of philosophy in America from colonial times to the present. II; ½ to 1 unit. Prerequisite: One course in philosophy. FISCH.

317. **Great Books in Modern Thought.** Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. I; ½ to 1 unit. Prerequisite: One course in philosophy. WILL.

319. **Philosophical Ideas in Latin America.** A survey of the main philosophical currents and thinkers of Latin America. I; ½ to 1 unit. Prerequisite: One course in philosophy or consent of instructor. KUBITZ.

321. **Ethics and Value Theory.** I; ½ to 1 unit. Prerequisite: One course in philosophy. DIGGS, FISCH.

323. **Philosophy of Art.** A discussion of the main philosophical principles of art and of outstanding contemporary philosophies of art. I; ½ to 1 unit. GOTSHALK.

324. **Philosophy of Religion.** II; ½ to 1 unit. Prerequisite: One course in philosophy.

326. **Metaphysics.** II; ½ to 1 unit. Prerequisite: One course in philosophy. LINSKY.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. I; ½ to 1 unit. Prerequisite: One course in philosophy. TURQUETTE.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. II; ½ to 1 unit. Prerequisite: One course in philosophy. WILL.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method, and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. I, II; ½ to 1 unit. Prerequisite: One course in philosophy. LINSKY, WILL.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. I; ½ to 1 unit. CHURCH, TURQUETTE.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. II; ½ to 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Philosophy 333 or consent of instructor. CHURCH, TURQUETTE.

336. **Philosophy of Law and of the State.** II; ½ to 1 unit. Prerequisite: One course in philosophy. DIESING.

337. **Semantics.** An investigation of semantical concepts such as denoting and truth. A study of the functions of language, definition, meaning and verification, semantical paradoxes. I; ½ to 1 unit. Prerequisite: One course in philosophy. LINSKY.

340. **Philosophy of Alfred North Whitehead.** An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas,* taking into account both the cosmological scheme and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. II; ½ to 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

350. **Philosophy and Modern Life.** A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. I or II; ½ to 1 unit. Prerequisite: One course in philosophy. GOTSHALK.

361. **Comparative Religions: Religions of the East.** A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. I; ½ to 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

362. **Comparative Religions: Religions of the West.** A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity and Islam. II; ½ to 1 unit. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

363. **Contemporary Religious Thought.** An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. I; ½ to 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

PHYSICAL EDUCATION

(Including Health Education and Recreation)

The department offers graduate study programs in the areas of physical education, health education, and recreation.

ASSISTANTSHIPS

A limited number of part-time teaching assistantships and part-time research assistantships are available in physical education, health education, and recreation. These appointments are made annually and are open to candidates for advanced degrees. Candidates for these positions must have a 4.0 grade average for the last two years of undergraduate study.

GRADUATE TEACHING FACULTY

Professors: S. C. STALEY (Director of School of Physical Education), C. K. BRIGHTBILL, T. K. CURETON, H. S. HOYMAN, LAURA J. HUELSTER, C. O. JACKSON, H. E. KENNEY, G. T. STAFFORD.

Associate Professors: F. E. BOYS, A. E. FLORIO, A. W. HUBBARD, R. H. JOHNSON, C. G. KNAPP, A. V. SAPORA.

Assistant Professors: ANNE E. JEWETT, H. E. WEAVER.

Physical Education

The department offers programs of graduate study leading to the degrees of Master of Science and Doctor of Philosophy in Physical Education. Both programs are centered in training teachers, administrators, and research workers in the general field of physical education, but also offer opportunities for training in the related fields of health education and recreation and the special fields of sports, dance, and exercise.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 (halfway between B and C) for that portion of the work which represents the last 50 per cent of the hours earned for the bachelor's degree; (2) thirty hours of approved undergraduate credit in physical education or related fields; (3) eighteen hours of approved undergraduate credit in science; (4) sixteen hours of undergraduate credit in education; and (5) a course in statistics or measurement. Students are not admitted on limited status.

Admission requirements for a minor in the department are twenty hours of physical education. Students who do not meet this requirement, however, may be admitted to certain courses, if approved by the instructor.

Degree of Master of Science. Graduation requirements for this degree are eight units (equivalent of thirty-two hours credit) to include (1) four units of credit in physical education or related (health education or recreation) courses; (2) two units of credit in education including two of the following one-half unit courses: Education 301, 302, 303, 304; and the following one-half unit courses: Education 311 and 312; (3) registration in and satisfactory completion of Physical Education 490 for one semester, without credit; (4) presentation of an acceptable thesis, two units.

Candidates may petition to waive the thesis and seminar requirements. Those who are excused are required to secure two units' credit in lieu of thesis credit (item 4) and in addition are required to take and pass a final comprehensive written examination in physical education and related fields.

Degree of Doctor of Philosophy. Graduation requirements for this degree are twenty-four units of graduate credit (equivalent of ninety-six hours of credit) including (1) a minimum of eight units of credit in physical education courses or related courses in health education or recreation, (2) one minor for a minimum of four units, or two minors for a minimum of two units each, (3) registration in and satisfactory completion of Physical Education 490, and (4) presentation of an acceptable thesis for approximately eight units.

Each candidate must pass a reading examination in French and German. No student is considered as beginning his second year of graduate work until he has passed one of these examinations. Both examinations must be passed before taking the preliminary examination.

Each candidate must pass a written examination covering his major field of study and an oral examination covering his major and minor fields of study. This preliminary examination is given toward the end of the second year of study or, by special permission, at the beginning of the third year (not later than November 1).

Each candidate must pass a final examination, principally on his thesis. This examination must be taken at least two weeks before the degree is to be conferred.

For additional information about these programs, write to Professor S. C. Staley, 108 Huff Gymnasium.

COURSES FOR GRADUATES

(Open to both men and women)

01. Problems in Physical Education. Biological, physiological, social, psychological, and other purposes and outcomes; selection and distribution of activities; teaching methods; facilities; teacher preparation; literature; research problems. I or II; 1 unit. HUELSTER, JACKSON, JOHNSON, KENNEY.

06. Philosophy of Sport. History of sport; cultural, educational, economic, health character, personality, military, therapeutic, and other implications; types and extent of participation; organization; literature; research programs. I or II; 1 unit. BRIGHTBILL, JACKSON, JOHNSON, KENNEY.

07. Sports Psychology. Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, perception and emotion in sports situations; review of literature; independent projects. I or II; 1 unit. Prerequisite: Psychology 100; Education 211; consent of instructor. HUBBARD.

0. Trends and Techniques in Rehabilitation. Philosophy of rehabilitation; education of the handicapped (blind and partially sighted, deaf and hard of hearing, mentally handicapped, socially maladjusted, crippled, cardiac, epileptic, speech deviate, etc.); state, federal, and community education and vocational training programs; literature; research. I or II; 1 unit. STAFFORD.

1. Scientific Foundations of Physical Fitness. Scientific basis for physical fitness; analysis of fitness programs; analysis of fitness tests; techniques in remedial clinics; literature; research. Includes laboratory session. I or II; 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. CURETON.

2. Scientific Analysis of Physical Education Activities. Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and

kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. I or II; 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. CURETON.

453. **Anthropometrical and Body Mechanics Research Techniques.** Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. I; 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. CURETON.

490. **Seminar.** Presentation and criticism of student theses; lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders. I, II; no credit. CURETON, HUBBARD, JACKSON, JOHNSON, STAFFORD.

491. **Thesis.** Preparation of theses in physical education. I, II; ½ to 4 units. STAFF.

493. **Research.** Independent research on special projects. Open only to students working toward the doctor's degree. I, II; ½ to 2 units. STAFF.

495. **Techniques of Research in Health, Physical Education, and Recreation.** Review and appraisal of common research procedures; application of statistical procedures, library methods, evaluation procedures, and experimental methods. I or II; 1 unit. CURETON, HUBBARD.

Health Education

The Department of Physical Education also offers a program of graduate study leading to the degree of Master of Science in Health Education. This program is centered in training teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for training in the special fields of public health education, safety education, and kinesitherapy.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for all courses taken during the last two years of undergraduate study; (2) thirty semester hours of approved undergraduate credit in health education or closely related courses; (3) twenty-four semester hours of approved undergraduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement. Students are not admitted on limited status.

Graduation requirements for this degree are eight units (equivalent of thirty-two semester hours credit) to include (1) four units in health education or approved courses in physical education; (2) two units in education, including two of the following one-half unit courses: Education 301, 302, 303, 304; and the following one-half unit courses: Education 311 and 312; (3) registration in and satisfactory completion of Health Education 490, without credit; (4) presentation of an acceptable thesis in health education, two units. The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in health education may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

For additional information about this program, write to Professor H. S. Hoyman, 114 Huff Gymnasium.

COURSES FOR GRADUATES

(Open to both men and women)

400. **Scientific Foundations of Health Education.** Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and prin-

ciples as these apply to the further improvement of personal, family, and community health. I or II; 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. HOYMAN, STAFFORD.

401. **Problems in School Health Education.** Deals primarily with the history, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. I or II; 1 unit. HOYMAN, JACKSON, STAFFORD.

402. **Problems in Safety Education.** Philosophy of safety; traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. I or II; 1 unit. FLORIO, STAFFORD.

403. **Problems in Public Health.** Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. I or II; 1 unit. HOYMAN.

404. **Trends and Issues in Sex Education.** A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of the philosophy, principles, methods, and current problems of sex education in Illinois and the United States. I or II; 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, or consent of instructor. HOYMAN.

490. **Seminar.** Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. I or II; no credit. STAFF.

491. **Thesis.** Preparation of theses in health and safety education. I, II; ½ to 2 units. STAFF.

493. **Research.** Research in school health and safety education. I, II; ½ to 2 units. Prerequisite: Education 390, Physical Education 495, and Health Education 400, or equivalent. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

390. **Public Health Education.** Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers. Projects in preparing and using public health education materials. Evaluation of research in public health education. I; ½ unit. Prerequisite: Consent of instructor. HOUGH, WITTENBORN.

391. **Public Health Statistics.** An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. II; ½ unit. Prerequisite: Mathematics 161 or Education 390, or equivalent. SAGEN.

Recreation

The Department of Physical Education also offers a program of graduate tudy leading to the degree of Master of Science in Recreation. This program s centered in training leaders, supervisors, administrators, teachers, and research vorkers in community recreation, but also offers opportunities for training in the elated fields of industrial and institutional recreation and specialization in given

program areas of recreation such as sports, music, dramatics, arts and crafts, camping and outdoor education, and the like.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 (halfway between B and C) for all courses taken during the last two years in earning the bachelor's degree; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate credit in the natural sciences; and (5) a course in statistics or tests and measurements. Applicants lacking a portion of the prerequisites under item (2) may substitute certified professional field experience, not to exceed eight semester hours. Students are not admitted on limited status.

Graduation requirements for this degree are eight units (equivalent of thirty-two semester hours credit) to include (1) four units of credit in approved courses to be chosen in the following areas: recreation, education, political science, psychology, social work, and sociology; (2) two units of approved electives to be chosen in the following areas: art, botany, geology, health education, landscape architecture, literature, music, physical education, speech, and zoology; (3) registration in and satisfactory completion of Recreation 490, without credit; (4) presentation of an acceptable thesis in recreation, two units. The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in recreation may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

For additional information about this program, write to Professor Charles K. Brightbill, 111 Huff Gymnasium.

COURSES FOR GRADUATES

(Open to both men and women)

401. **Foundations of Recreation.** Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. I or II; 1 unit. Prerequisite: Recreation 176 or equivalent. Brightbill.

402. **Recreation Administration.** Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. I, II; 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent. Brightbill.

403. **Evaluation of Recreation Resources and Programs.** Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; and research in the field of recreation. I or II; 1 unit. Prerequisite: Recreation 176 or 275 or equivalent; a course in tests and measurements or statistics. Sapora.

404. **Outdoor Education and Recreation.** Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. II; 1 unit. Prerequisite: Recreation 174 or equivalent; one undergraduate course in biology, botany, geology, or zoology. Weaver.

490. **Seminar.** Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. I, II; no credit. Staff.

491. **Thesis.** Preparation of theses in recreation. I, II; ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

375. **Organization of Recreation Programs.** Organization of public and private agency programs, leadership, facilities and services, and introduction to recreation administration. I, II; ½ unit. Prerequisite: Recreation 176. SAPORA.

PHYSICAL SCIENCES

A special program leading to the degree of Master of Science in the Physical Sciences is available to meet the needs of students who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit carry credit toward the degree. To qualify for the degree, a student must have had, or must include in his program, at least one course in mathematics beyond calculus, and for which calculus is prerequisite.

Candidates for the degree of Master of Science in the Teaching of the Physical Sciences must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in the physical sciences and the electives must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 3.5 for that portion of work which represents the last 50 per cent of the hours earned for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. The adviser for candidates for this degree is Professor J. C. Bailar, Jr., 107 Chemistry Annex.

PHYSICO-CHEMICAL BIOLOGY (BIOPHYSICS)

Training for the degree of Doctor of Philosophy in Physico-Chemical Biology (biophysics) is administered by a committee of the Division of Biological Sciences. The chairman of this committee is Professor Robert Emerson, 155 Natural History Building. The purpose of this curriculum is to offer to students who wish to prepare for a career in biological research a training which combines courses in physics and chemistry with study of the fundamentals of biology as illustrated by some natural group of organisms. The majority of biological work ordinarily is in one of the biological departments (Bacteriology, Botany, Entomology, Physiology, Zoology), but may be divided among these fields to suit the needs of the candidate.

Research facilities are available in cellular physiology, microbiology, photosynthesis, electrophysiology, diffusion processes, and radiobiology.

Applicants for admission must have a grade-point average of at least 4.0 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training.

Minimum admission requirements are college biology (six hours), college physics (eight hours), analytical and organic chemistry, and calculus. Deficiencies in any of these requirements may be made up during the first year of

graduate study, but no graduate credit is given. A total of six hours of calculus is needed as prerequisite for the physics requirement listed below.

All candidates are required to take the following courses, or show equivalent credits:

(1) Chemistry: two units from Chemistry 340, 341, 342, 343, 344, 345, Physical Chemistry; 350, Biochemistry; 336, 337, Organic Chemistry.

(2) Physics: two units from Physics 341, 342, Electricity; 371, 372, 374, Light; 360, Thermodynamics; 281, 381, Atomic Physics; 362, Kinetic Theory and Statistics; 382, Nuclear Physics.

(3) Cytology or genetics: one unit from Zoology 403, Cytology; 456, Physiological Genetics; 351 and 352, Genetics; 455, Advanced Genetics; Botany 320, Cytology, or 322, Genetics; Botany 420, Cytogenetics; Bacteriology 405, Microbiological Genetics.

(4) Physiology: one unit from Physiology 306 or 307, Mammalian Physiology; 361, Comparative Physiology; 362, Cellular Physiology; Botany 333 or 335, or 433, Plant Physiology; or Entomology 421 and 423 or 422 and 424, Insect Physiology.

(5) Advanced biology: two units from the following: Zoology 333, Vertebrate Embryology; 320, Invertebrate Zoology; 318, Protozoology; 334, Vertebrate Histology; 332, Advanced Vertebrate Zoology; Botany 302, 303, or 304, Morphology; 345, Plant Anatomy; 322, Heredity and Evolution; 372, Mycology; 402, Physiological Genetics; 472, Industrial Molds; 340, Histology, Microtechnique; Bacteriology 300, General Bacteriology; 306, Principles of Experimental Bacteriology; 351, Viruses; Entomology 322, Insect Bionomics, or 407, Insect Anatomy.

Eight additional units are chosen from selected areas of biology, physics, chemistry, or mathematics.

All students in the curriculum are expected to take Biological Sciences 331, 332, and 333, Radiobiology, Photobiology, and Electrobiology; Physiology 462, Advanced General Physiology, and Physiology 470, Advanced Cellular Physiology.

Other courses suitable to supplement the curriculum are Bacteriology 404, Quantitative Analysis of Bacteriological Procedures; 420, Chemistry of Microbic Processes; 451, Experimental Virology; 425, Bacterial Metabolism; Zoology 363, Endocrinology; 404, Experimental Cytology; 467, Experimental Embryology; Botany 419, Photosynthesis and Related Subjects.

If some of the above requirements have already been fulfilled by undergraduate work, the student must submit for approval of the committee additional work of equivalent credit and corresponding level.

After completion of a minimum of sixteen units of graduate work, a written preliminary examination is required. This is followed by an oral examination given by a committee appointed by the Dean of the Graduate College. For students transferring from other universities, one semester of graduate work at the University of Illinois is required before admission to the preliminary examination.

Subject to approval by the committee, candidates for the degree of Doctor of Philosophy in other fields may take a minor in physico-chemical biology.

FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships are available in physico-chemical biology. Applications for fellowships should be made on forms provided by the Graduate College and should be forwarded to the Dean of the Graduate College.

No teaching assistantships are available in physico-chemical biology, because the curriculum is interdepartmental in character. Applications for teaching

assistantships should be sent to the head of the department in which the candidate would like to have teaching experience.

A few research assistantships are available by arrangement with staff members who have special research projects.

PHYSICS

The Department of Physics offers graduate work leading to the Master of Science and Doctor of Philosophy degrees.

There is opportunity for specialization in nuclear physics, including research with the betatrons, the cyclotron, and with radioactive sources; in nuclear magnetic resonance; in cosmic rays; in theoretical physics; in the physics of solids, including research on metals, semi-conductors and cryogenics; and, to a limited extent, in biophysics.

The requirements for admission to the Graduate College with a major in physics are twenty semester hours in physics, including Physics 321, 341, and 342 or the equivalent, and excluding courses in general physics and others numbered below 270; a grade average of at least 3.75 for that portion of the work which represents the last 50 per cent of the hours completed for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Students who lack some of the prerequisite courses may be admitted but are required to take the prerequisite courses without graduate credit.

Students admitted to the Graduate College with a major in another department may, with the consent of their adviser, elect a minor in physics provided they satisfy the prerequisites for the physics courses they elect.

The requirements for the Master of Science degree in physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the degree of Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department. This pamphlet also contains more detailed descriptions of the courses in physics and related courses in mathematics and suggests appropriate course sequences.

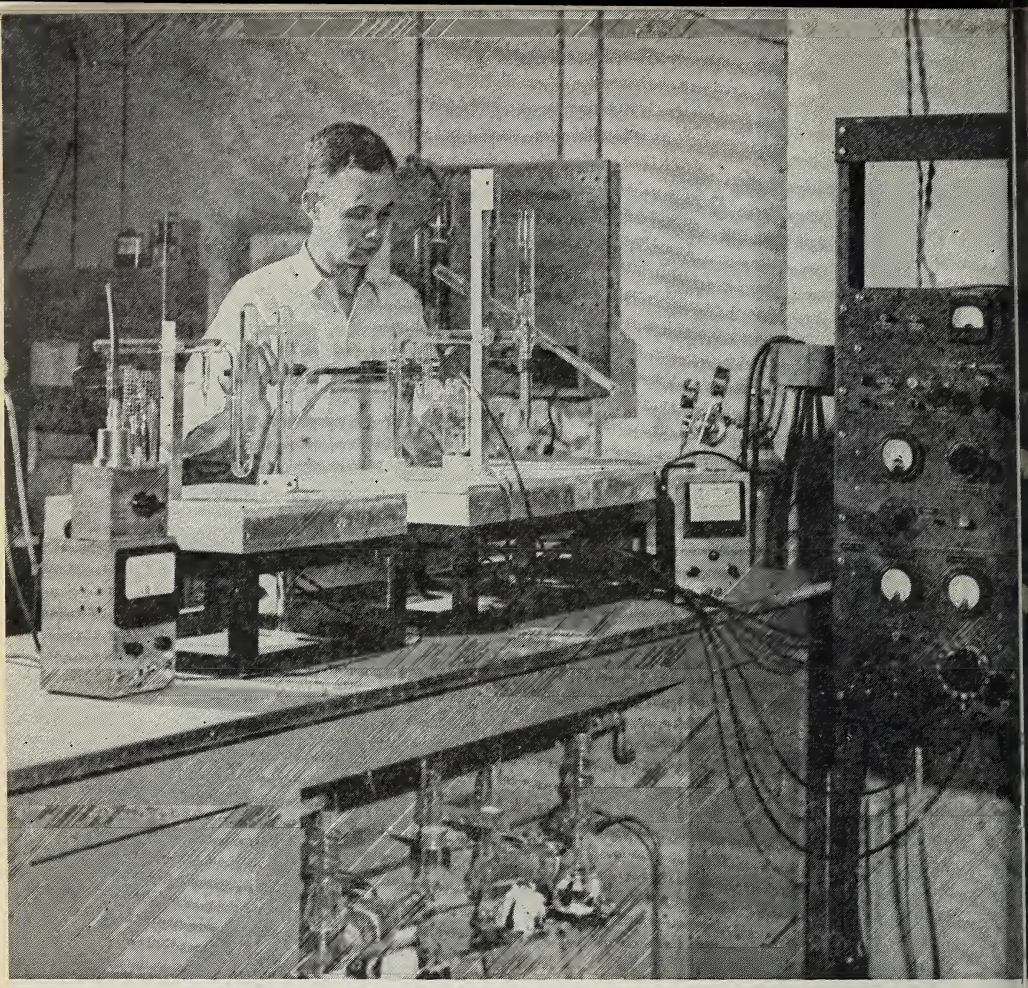
Candidates for the degree of Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Education 311, 312, and one additional unit in education selected from Education 301, 302, 303, and 304. Students applying for admission must have the same grade-point average as that required by the department. Those on limited status are not admitted to this program. The adviser for candidates for this degree is Professor G. M. Almy, 205 Physics Laboratory.

For information concerning applied mathematics, see page 28.

FELLOWSHIPS AND ASSISTANTSHIPS

The Graduate College offers fellowships for which students in physics are eligible, and in addition the Physics Department has a few industrial fellowships. The latter are usually awarded to students who have been in the University for two or more semesters. Applications for either University or industrial fellowships should be addressed to the Dean of the Graduate College.

The department employs a number of half-time graduate teaching and research assistants. Research assistants are expected to be advanced graduate students or to have technical experience of value to the research programs of the department. Inquiries about and applications for these positions should be addressed to the head of the department, 205 Physics Laboratory.



A graduate student in physics investigates surfaces of metals under extremely high vacuum.

GRADUATE TEACHING FACULTY

Professors: F. W. Loomis (Head of Department), J. S. Allen, G. M. Almy, J. Bardeen, J. H. Bartlett, R. A. Becker, G. Bernardini, G. F. Chew, A. O. Hanson, R. D. Hill, R. I. Hulsizer, W. K. Jentschke, D. W. Kerst, J. S. Koehler, P. G. Kruger, A. Longacre, E. M. Lyman, R. J. Maurer, R. E. Meagher, A. T. Nordsieck, C. S. Robinson, F. Seitz, C. W. Sherwin, C. P. Slichter.

Associate Professors: P. Axel, R. B. Duffield, L. S. Lavatelli, D. Lazarus, F. E. Low, D. E. Mapother, R. F. Paton, J. N. Snyder.

Assistant Professors: E. Abrahams, G. Ascoli, F. J. Blatt, F. C. Brown, G. Chiarotti, A. M. Feingold, H. Frauenfelder, E. L. Goldwasser, L. J. Koester, R. D. Rawcliffe, J. H. Smith, T. Suzuki, R. M. Thomson, C. T. Tomizuka, J. Weneser, J. C. Wheatley.

Associates: G. F. Bassani, J. F. Cochran, L. N. Cooper, U. Gonser, U. Haber-Schaim, R. R. Hake, N. Inchauspe, S. D. Johansson, A. H. Kahn, A. C. Odian, B. Okkerse, W. Palmer, R. A. Schmitt, P. Stähelin, S. H. Vegors.

Instructor: W. John.

COURSES FOR GRADUATES

400. **Problems and Methods of Theoretical Physics.** Vector analysis. Boundary value problems. The equations of mathematical physics; variational derivation; contour integration; ordinary differential equations; boundary conditions; Green's functions; Eigen-functions; Laplace's and Poisson's equations in one, two, and three dimensions; conformal mapping; integral representation; asymptotic expansions. I; 1 unit. Prerequisite: Mathematics 342, 345, 347, or 387; Physics 322 and 342; or consent of instructor.

403. **Experimental Research Techniques.** Intended to bridge the gap between the undergraduate laboratory work and actual research in experimental physics. Introduction to the elements of glassblowing; experiments on the production and measurement of high vacuums, the detection of particles, X-rays, nuclear induction, microwaves, electron diffraction, and a number of other problems in nuclear and atomic physics including nuclear spectroscopy and mass spectroscopy. The student has wide latitude in selecting the experiments and techniques which interest him. I, II; 1 unit. Prerequisite: Physics 343, or consent of instructor.

404. **Experimental Research Techniques.** Continuation of Physics 403. The student usually selects a more advanced research project which he pursues for most of the semester. I, II; 1 unit. Prerequisite: Physics 403.

422. **Dynamics.** LaGrange equations, small vibrations; Hamilton's canonical equations; Hamilton's principle, least action; contact transformations; Hamilton-Jacobi equation; perturbation theory; non-linear mechanics. II; 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. **Relativity and Cosmology.** Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. McVittie.

435. **Conduction of Electricity in Solids.** Same as Electrical Engineering 435. Application of quantum principles to conduction of electricity in solids, impurity and intrinsic semiconductors, Hall and thermoelectric effects, photo-

conductivity, p-n junctions and rectifying contacts, theory and characteristics of transistors. II; 1 unit. Prerequisite: Physics 381 or Electrical Engineering 425 or consent of instructor. BARDEEN.

436. **Selected Topics in Physics of Solids.** The following topics are offered one each semester, normally in a two-year sequence:

(a) **Imperfections in Metals.** Influence of point inperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, physical properties on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) **Imperfections in Ionic Crystals.** Theory of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the electronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.

(c) **Advanced Quantum Theory of Solids.** Theory of electrons in crystals on basis of Bloch theory and Brillouin zone structure with applications to various problems such as cohesive energy of metals, magnetic properties and the de Haas-van Alphen effect, optical properties, spin orbit interactions, excitons and energy transfer. 1 unit. Prerequisite: Physics 486 and 490.

(d) **Conduction in Metals and Semiconductors.** Electrical and thermal conduction, transverse effects, magneto-resistance, vibrational motion and electron-lattice interactions, semiconductors, superconductivity. 1 unit. Prerequisite: Physics 485 and 490.

441. **Electrodynamics.** Electrostatics; Poisson's equations; Laplace's equation; boundary value problems; spherical harmonics; multipole potentials; dielectrics; microscopic and macroscopic fields; susceptibility; magnetostatics: vector potential, magnetic multipoles; magnetic media: ferro-, dia-, paramagnetism; conducting media; Maxwell's equations: field energy and momentum; retarded potentials; fields due to moving charges: Lienard-Wiechert potential, fields of an accelerated charge. I; 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor.

442. **Electrodynamics.** Continuation of Physics 441. Self force of a finite electron; multipole radiation; propagation of radiation in material media: wave guides, modes of propagation, skin effect; special relativity; Lorentz-Abraham electron. II; 1 unit. Prerequisite: Physics 441.

463. **Statistical Mechanics.** Statistical ensembles; the Maxwell-Boltzmann law; approach to equilibrium; quantum statistical mechanics; application of statistical mechanics to thermodynamic processes. I; 1 unit. Prerequisite: Physics 422; Physics 360 or 362.

464. **Dynamics of the Earth's Atmosphere.** Same as Astronomy 464 and Mathematics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. MCVITTIE.

481. **Line Spectra and Atomic Structure.** A lecture and problem course presenting the experimental basis for quantum theory, an introduction to wave mechanics, and applications to atomic and molecular structure. Topics include photoelectric effect, Planck's law of radiation, electron and neutron diffraction, simple and complex atomic spectra, X-ray spectra, hyperfine

structure, molecular structure and molecular spectra. I or II; 1 unit. Prerequisite: Physics 322 and 342.

483. **Nuclear Physics.** Basic properties of nuclei; principles of high energy accelerators, particle and radiation detectors, and of precision measuring apparatus; alpha-, beta-, and gamma-decay of nuclei; nuclear masses and systematics of nuclei; nuclear models. I; 1 unit. Prerequisite: Physics 481.

484. **Nuclear Physics.** Nuclear reactions and nuclear models; fission; nuclear scattering and nuclear forces; high energy nuclear physics; meson production and interactions; unstable heavy particles; electro-magnetic interactions. II; 1 unit. Prerequisite: Physics 483.

485. **Quantum Mechanics.** Schrödinger wave equation, stationary state solutions; operators and matrices; perturbation theory, non-degenerate and degenerate cases; WKB approximation, non-harmonic oscillator, etc.; collision problems, Born approximation, method of partial waves. I; 1 unit. Prerequisite: Physics 481 and 422; Physics 400 or consent of instructor.

486. **Quantum Mechanics.** Time dependent perturbation theory, elastic and inelastic scattering, absorption of light; wave functions for identical particles, quantum statistics; Pauli spin operator; classification of atomic states; Thomas-Fermi model; quantization of radiation field; interaction of light with matter; Dirac electron theory. II; 1 unit. Prerequisite: Physics 485.

487. **Topics in Advanced Quantum Theory.** The following topics are offered alternately, each not oftener than once in three semesters.

(a) **Advanced Quantum Mechanics.** Quantum theory of scattering: boundary conditions, S-matrix and reactance matrix; application of symmetry principles: Lorentz and gauge invariance, time reversal, charge conjugation; many-body problems. I or II; 1 unit. Prerequisite: Physics 486.

(b) **Quantum Electrodynamics.** Field quantization; scalar meson field; Dirac electron, electron-positron theory; electrons in external fields; interacting electrons and photons: transition probabilities, Lamb shift, S-matrix and Feynman graphs, Moeller and Compton scattering, electron self-energy, renormalization, anomalous electron magnetic moment. I or II; 1 unit. Prerequisite: Physics 486.

488. **Topics in Theoretical Nuclear Physics.** The following topics are offered:

(a) **Nuclear Structure and Transformations.** The two-nucleon problem; interaction of electromagnetic radiation with nuclei; beta decay; theory of nuclear reactions. I or II; 1 unit. Prerequisite: Physics 484 and 486.

(b) **Mesons and High-Energy Nuclear Physics.** Basic properties of pi-mesons and other sub-nuclear particles; production, absorption, and scattering of pi-mesons; meson theory of nuclear forces; scattering of gamma rays by nucleons; high-energy reactions in complex nuclei. I or II; 1 unit. Prerequisite: Physics 484 and 486.

489. **Theory of Solids.** Reviews the introductory phases of the modern theory of crystalline materials. Topics treated include the classical theory of ionic crystals, specific heats, electron theory of metals and semi-conductors, the band approximation. I; 1 unit. Prerequisite: Physics 360, 362, 381, or consent of instructor.

490. **Theory of Solids.** Continuation of Physics 489. The electronic structure of solids, optical and magnetic properties, crystal lattice imperfections, diffusion and ionic conductivity, cooperative phenomena, superconductivity. II; 1 unit. Prerequisite: Physics 489, or consent of instructor.

493. **Research.** I, II; 1 to 4 units.

498. **Seminar.** A course number used when it is desirable to give credit for individual but supervised study of a subject not covered by regular courses. It is also used for formally organized special topics seminars for which credit is given. I, II; 1 to 2 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. **Theoretical Mechanics.** Laws of motion, vectors, statics, energy and momentum principles for a particle and for systems of particles, motion of a particle under constant forces, plane motion of a rigid body, simple harmonic motion and resonance, impact. Lectures and problems. Physics 321 and 322 are fundamental to many advanced courses, and should be elected as early as possible by those intending to specialize in physics. I, II; 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics and calculus.

322. **Theoretical Mechanics.** Continuation of Physics 321. Motion of a particle under a variable force, central field motion, accelerated reference systems, motion of a particle subject to constraints, rotation of a rigid body in three dimensions, vibrating systems and normal coordinates, generalized coordinates. I, II; 1 unit. Prerequisite: Physics 321.

330. **Sound.** Fundamentals of wave motion as related to sound and vibration: origin, propagation, interference, refraction, and diffraction of sound; vibration of strings and air columns; some applications of sound theory; musical instruments, loud speakers, signalling and detecting devices; study of speech and hearing. Lectures and problems. II; 1 unit. Prerequisite: General physics and calculus.

341. **Electricity and Magnetism.** Fundamental laws logically developed and summarized in Maxwell's equations; forces and energies associated with electric and magnetic properties of matter; generation and propagation of electromagnetic waves. Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. I; ½ to 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics and calculus; registration in Mathematics 341 or 343, or consent of instructor.

342. **Electricity and Magnetism.** Continuation of Physics 341. Boundary conditions and special methods in boundary value problems; interpretation of dielectric and magnetic properties of matter from the point of view of atomic and crystalline properties; use of complex notation in circuit problems; coupled circuits; non-linear circuits, transmission lines; radiation from antennas; transmission and reflection of electromagnetic waves. II; ½ to 1 unit. No credit is given to graduate physics majors. Prerequisite: Physics 341.

343. **Vacuum Tube Circuits.** The physics of vacuum tubes, rectifiers and cathode-ray tubes and associated circuits; elementary theory and applications of vacuum tubes as linear circuit elements in amplifiers and electronic instruments. Emphasis is on experimental techniques. Lectures, problems, and laboratory. II; 1 unit. Prerequisite: Physics 341.

344. **Vacuum Tube Circuits.** Continuation of Physics 343. Electronic instruments and techniques used in research in physics: advanced theory and experiments emphasizing the use of vacuum tubes as non-linear circuit elements, e.g., multi-vibrators, blocking oscillators, pulse generators and amplifiers, geiger counter circuits, synchronizing and time-measuring circuits, and

introduction to transistor circuitry. I; 1 unit. Prerequisite: Physics 343 or equivalent.

360. **Thermodynamics.** The first, second, and third laws of thermodynamics; the properties of the entropy, enthalpy, free energy, and internal energy functions; reversible and irreversible processes; applications to homogeneous and heterogeneous systems; chemical reactions and the mass action law. Lectures and problems. I, II; 1 unit. Prerequisite: General physics and calculus.

362. **Kinetic Theory and Statistics.** A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and applications. I, II; 1 unit. Prerequisite: Physics 360 or consent of instructor.

371. **Light.** Geometrical optics: image formation, thick lens theory, aberrations, photometry of optical systems, optical instruments; wave optics: interference and diffraction. Lectures, problems, and laboratory. I; ½ to 1 unit. Prerequisite: General physics and calculus.

372. **Light.** Continuation of Physics 371. Electromagnetic character of light, Maxwell's equations, theory of reflection and refraction, polarization, double refraction, crystal optics, dispersion, scattering, optical properties of metals. II; ½ unit. Prerequisite: Physics 371.

374. **Light Laboratory.** To accompany Physics 372 and continue laboratory work of Physics 371. In addition to experiments related to topics of Physics 372, there are available a number of experiments in spectroscopic techniques and analysis. These include studies of the properties of photographic plates, chemical spectroscopic analysis, analysis of atomic and molecular spectra, Zeeman effect, Raman and fluorescence spectra. II; ½ unit. Prerequisite: Registration in Physics 372 or consent of instructor.

381. **Atomic Physics.** Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics include the atomic nature of matter, the properties of free electrons, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, an introduction to the ideas of quantum mechanics, binding in molecules and crystals, and an introduction to some solid state phenomena. I, II; 1 unit. Prerequisite: General physics and Mathematics 343 or 345, or consent of instructor.

382. **Nuclear Physics.** A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. II; 1 unit. Prerequisite: Physics 381.

385. **Introduction to Quantum Mechanics.** Schrödinger equation, stationary states; hydrogen atom; perturbation theory; electron spin; the exclusion principle; many electron atoms; interatomic forces and molecular structure. Recommended primarily to students of the physical sciences other than physics who desire an introductory course in the aspects of quantum mechanics which are basic to a modern understanding of atoms, molecules, solids, elementary atomic processes and chemical reactions. I; 1 unit. Prerequisite: Physics 381, Mathematics 343 and 345 or equivalent, or consent of instructor.

PHYSIOLOGY

Graduate work in physiology is offered leading to the degrees Master of Science and Doctor of Philosophy. Admission of beginning graduate students to full status requires a grade-point average no lower than 3.5 for that portion of undergraduate work representing the last 50 per cent of the hours completed for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. There is no departmental requirement of specific undergraduate major or minor fields, but graduate students whose background is deficient in chemistry, physics, biological sciences, or mathematics (which are all essential for graduate work in physiology) must rectify these deficiencies early in their graduate careers.

Degree of Master of Science. To obtain the degree Master of Science, the student must offer at least eight units of acceptable course work in physiology and related subjects. Ordinarily, the program includes Physiology 306 and 307, Advanced Mammalian Physiology; 361, Comparative Physiology; and 362, Cellular Physiology. During the semester when the candidate wishes to obtain the degree, he is examined in writing and orally by a departmental committee. The results of this general examination are taken into consideration by the committee in deciding whether or not he is certified for the degree, and whether or not he is accepted into the doctoral program of the Department of Physiology. No more than one unit of Physiology 481, Individual Topics, can be applied toward a master's degree; students offering Physiology 481 are expected to submit a term paper or brief research report to the adviser and the examining committee. Two units of Physiology 491, Research, and a thesis may be substituted for two units of course work.

Degree of Doctor of Philosophy. Permission to study toward the doctorate must be obtained from the Graduate College and the department's graduate committee. A student whose master's degree was obtained in the department is judged by his past record and by the results of the required written and oral examination. Transfer students whose master's degrees were obtained elsewhere are examined orally and in writing by the graduate committee toward the end of the first year of residence, and the results of this general examination determine in part whether or not they may continue toward the doctorate in this department. In their cases, this examination also determines what transfer credit is allowed toward the doctoral requirements for work completed elsewhere.

To obtain the degree of Doctor of Philosophy, the candidate must comply with the general regulations of the Graduate College concerning majors and minors, grades, units of work, foreign languages, residence, preliminary examination, thesis, and final examination. The department requires that the candidate pass a written comprehensive examination covering important areas of physiology before he is permitted to take his oral preliminary examination. Six written three-hour papers are required: one each in general mammalian physiology, comparative physiology, and cellular physiology; one on his minor area; one on philosophy of science, history of biology, and biostatistics; and one on current physiological concepts related to his special area.

Each candidate must take, either as an undergraduate or a graduate student, the following courses or their equivalents: Physiology 306 and 307, Advanced Mammalian Physiology; 361, Comparative Physiology; 362, Cellular Physiology; 490, the department's introductory graduate course; Chemistry 347, Elementary Physical Chemistry; 350 and 355, General Biochemistry; Zoology 333, Vertebrate Embryology; 334, Vertebrate Histology; 351, Genetics.

In addition to satisfying the department's basic requirements for all students, each candidate specializes by following a program in one of the following areas: mammalian physiology, comparative physiology, cellular physiology, biophysics,

endocrinology, neurophysiology, human anatomy and human physiology, bioclimatology, radiobiology, or electrobiology. An intra-departmental minor may be offered in most of these permissible areas of specialization, chosen from sequences other than Physiology 306, 307, 361, and 362. Details of the various specialized programs can be obtained at the departmental office, 401 Natural History Building.

Minors. Graduate students majoring in other departments who wish to obtain a minor in physiology should see the head of the Physiology Department as early as possible in their graduate studies for discussion of a program and assignment of a departmental minor adviser. For a sole minor, a candidate from another department must offer four courses. For a first minor, three courses are required, two of which must include laboratory work. For a second or split minor, two laboratory courses are required. Courses recommended depend upon the needs of the individual student; usually, a sequence of courses within one area of physiology is desirable. Possible areas for sole and first minors are: cellular physiology (including radiobiology, electrobiology, and biophysics) comparative physiology, mammalian physiology, human anatomy and human physiology, endocrinology, neurophysiology, and bioclimatology.

For work in physico-chemical biology (biophysics), see page 233.

ASSISTANTSHIPS

Each year the department appoints a number of graduate teaching and research assistants, with stipends set by the general regulations of the University. Inquiries should be directed to the department office, 401 Natural History Building. Students whose major interest is in biophysics are eligible for teaching and research assistantships in the Department of Physiology.

GRADUATE TEACHING FACULTY

Professors: R. E. Johnson (Head of Department), C. L. Prosser, F. R. Steggerda, A. B. Taylor.
Associate Professors: W. P. Elhardt, F. Sargent II.
Assistant Professors: J. D. Anderson, W. H. Johnson, S. G. Stolpe.

COURSES FOR GRADUATES

401. **Mammalian Physiology Seminar.** Current trends in mammalian physiology. I or II; ½ unit. Prerequisite: Two semesters of mammalian physiology or equivalent; consent of instructor. Steggerda.

403. **Experimental Mammalian Physiology, I.** The physiological applications of experimental mammalian surgery. I, II; 1 unit. Prerequisite: Two semesters of advanced mammalian physiology or equivalent; consent of instructor. Steggerda.

404. **Experimental Mammalian Physiology, II.** The physiological applications of experimental pharmacodynamics. I or II; 1 unit. Prerequisite: Physiology 306 and 307, or equivalent; consent of instructor. Steggerda.

416. **Structure and Function of the Nervous System.** The understanding of nervous function through the experimental approach. II; 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. W. H. Johnson.

421. **Gross Human Anatomy.** A general survey of the structures of the human body, with emphasis on the relations between form and function. I or II; 1 unit. Prerequisite: One semester of embryology; consent of instructor. Elhardt.

441. **Fundamentals of Bioclimatology.** Same as Geography 441. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological and pathophysiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. I or II; ¾ unit. Prerequisite: Consent of instructor. PAGE, SARGENT.

442. **Experimental Bioclimatology.** Same as Geography 442. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. I or II; ½ unit. Prerequisite: Physiology 306 and 307; credit or registration in Physiology 441. PAGE, SARGENT.

443. **Advanced Human Bioclimatology.** Same as Geography 443. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. I or II; ½ unit. Prerequisite: Physiology 441. PAGE, SARGENT.

450. **Human Pathologic Physiology.** Disturbances of function in tissues and organs, and their relationship to the pathogenesis of human disease. I or II; ¾ unit. Prerequisite: Physiology 306 and 307; Chemistry 350 and 355; consent of instructor. R. E. JOHNSON.

451. **Human Pathologic Physiology Laboratory.** Laboratory methods for measuring the function of organs in the human. I or II; ½ unit. Prerequisite: Credit or registration in Physiology 450; consent of instructor. R. E. JOHNSON.

452. **Human Physiology Seminar.** Topics of current emphasis in human physiology. I or II; ½ unit. Prerequisite: Physiology 306 and 307; Chemistry 350 and 355; consent of instructor. R. E. JOHNSON.

462. **Advanced General Physiology.** Same as Zoology 462. Seminar, lectures, student reports, discussions. I or II; ½ unit. Prerequisite: Consent of instructor. PROSSER.

470. **Advanced Cellular Physiology.** The functional organization of macromolecular systems in living cells, with emphasis on experimental techniques. I or II; 1 unit. Prerequisite: One year of general physics, calculus, and physical chemistry; Physiology 362. W. H. JOHNSON.

481. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. Not more than one unit in Physiology 481 may be offered toward a master's degree. I, II; ½ to 1 unit. Prerequisite: Approval of department. STAFF.

490. **Areas and Concepts of Physiology.** The general concepts and methodology of physiology in its various special fields. Required of all graduate majors in physiology during their first year of residence. I or II; ¼ unit. Prerequisite: Graduate major in physiology. STAFF.

491. **Research.** I, II; ¼ to 4 units. STAFF.
Research may be conducted in the following areas, with the consent of the instructor:

(a) **Cellular Physiology, Biophysics, Electrobiology, and Radiobiology.** ANDERSON, W. H. JOHNSON, PROSSER, TAYLOR.
(b) **Comparative Physiology.** ANDERSON, PROSSER.
(c) **Mammalian Physiology.** STEGGERDA.
(d) **Human Anatomy and Human Physiology.** ELHARDT, R. E. JOHNSON, STOLPE, TAYLOR.
(e) **Endocrinology.** STOLPE.
(f) **Neurophysiology.** W. H. JOHNSON.

(g) **Bioclimatology.** SARGENT.
(h) **Environmental and Stress Physiology.** R. E. JOHNSON, SARGENT, STEGGERDA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Advanced Mammalian Physiology.** The significance of muscle, nerve, blood, and circulation in mammalian physiology. I; 1 unit. Prerequisite: Courses totaling twenty hours in chemistry, animal biology, or both, beyond the introductory freshman courses; consent of instructor. STEGGERDA.

307. **Advanced Mammalian Physiology.** The significance of respiration, digestion, metabolism, excretion, temperature regulation, and hormones in mammalian physiology. II; 1 unit. Prerequisite: Courses totaling twenty hours in chemistry, animal biology, or both, beyond the introductory freshman courses; consent of instructor. STEGGERDA.

331. **Physico-Chemical Biology, Part I: Radiobiology.** Same as Biological Sciences 331. Action of ionizing radiations on living organisms. I or II; 1 unit. Prerequisite: One year each of biology, physics, chemistry, and mathematics.

333. **Physico-Chemical Biology, Part III: Electrobiology.** Same as Biological Sciences 333 and Botany 333. Potentials produced by and effects of potentials upon living organisms. Lectures, student reports, and demonstrations. I or II; ¾ unit. Prerequisite: Ten hours of biology; four hours of physical chemistry; ten hours of physics. PROSSER.

361. **Comparative Physiology.** Same as Zoology 361. A comparison of the general physiology of different groups of animals. I; 1 unit. Prerequisite: Three semesters of animal biology; two semesters of chemistry. ANDERSON, PROSSER.

362. **Cellular Physiology.** Same as Zoology 362. A physico-chemical analysis of biological functions common to most living cells. II; 1 unit. Prerequisite: Two semesters each of biology and general physics; three semesters of chemistry. ANDERSON, PROSSER.

363. **Endocrinology.** Same as Zoology 363. The glands of internal secretion with special reference to the vertebrates. I annually; II in 1958-1959 and in alternate years; 1 unit. Prerequisite: One semester of elementary zoology or physiology; Zoology 334 or organic chemistry. HALL.

PLANT PATHOLOGY

Students may choose a major, joint major, or minor in plant pathology. The following fields are available for specialization in plant pathology: diseases of field crops, forest and shade trees, fruit crops, ornamentals, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science degree must meet the general requirements of the Graduate College and must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination before a committee of five staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy degree must meet the general requirements of the Graduate College regarding foreign languages, special examinations, minors, and theses.

Beginning graduate students with a grade-point average of at least 3.75 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, are admitted to full standing. Students are not admitted on limited status.

FELLOWSHIPS AND ASSISTANTSHIPS

A number of fellowships are available in the Graduate College. For a description of these, refer to the beginning section of this catalog. In addition, the Department of Plant Pathology has research assistantships available for students majoring in this field. Applications for assistantships in plant pathology should be sent to the Department of Plant Pathology, 218 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: M. B. Linn (Acting Head of Department), W. M. Bever, L. M. Black, J. C. Carter, D. Gottlieb, B. Koehler, M. B. Linford, D. Powell, H. H. Thornberry.
Associate Professor: J. W. Gerdemann.
Plant Pathologist: D. W. Chamberlain.

COURSES FOR GRADUATES

401. **Diseases of Forest and Shade Trees.** A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. II; ½ to 1 unit. Prerequisite: Plant Pathology 317 or consent of instructor. Carter.

403. **Physiology of Fungi.** Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. I; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Organic or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

404. **Plant Virology.** Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, staining, assay, filtration, and purification; control methods; sources of information; history of virology. II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Consent of instructor. Thornberry.

417. **Discussions in Plant Pathology.** Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. I, II; ¼ unit. Gottlieb and staff.

424. **Advanced Plant Virology.** Purification and special properties of virus nucleoproteins or selected virus diseases are considered. Different specific topics for concentrated study may be selected for subsequent semesters depending upon the student's interest. A specific topic pertinent to the student's thesis problem may be selected. Theories and original data are to be critically analyzed and evaluated. II; ½ to 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Plant Pathology 404 or consent of instructor. Thornberry.

491. **Thesis.** Research on the thesis problem in plant pathology. I, II; ½ to 4 units. Bever, Black, Carter, Chamberlain, Gerdemann, Gottlieb, Koehler, Linford, Linn, Powell, Thornberry.

492. **Research.** Same as Botany 493e. Work may be taken in the following fields subject to approval of one of the staff: fruits, vegetable and canning crops, field crops, ornamentals, forest and shade trees, virology, mycology, physiology of microorganisms, nematodes. I, II; ½ to 4 units. Bever, Black, Carter, Chamberlain, Gerdemann, Gottlieb, Koehler, Linford, Linn, Powell, Thornberry.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Fruit Diseases.** Same as Horticulture 307. Symptomatology; laboratory and field studies of representative diseases; control measures. II; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. POWELL.

308. **Vegetable and Canning Crop Diseases.** Same as Horticulture 308. Symptomatology; laboratory and field studies of representative diseases; control measures. I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. LINN.

317. **Plant Pathology.** Same as Botany 317. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science, including Botany 100. BLACK.

Botany 372. General Mycology. Structure, classification, and identification of fungi, including those of economic importance. Modification of the course is made to meet the needs of teachers and prospective teachers during the summer. II; 1 unit. Prerequisite: One year of botany, bacteriology, entomology, or zoology. SHANOR.

377. **Diseases of Field Crops.** Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Plant Pathology 317 or consent of instructor. BEVER, GERDEMANN.

379. **Research Methods in Plant Pathology.** Same as Botany 379. Techniques for the isolation, identification, culture of and inoculation with plant pathogens; methods for the histological study of diseased plants; recording of data. I; ½ unit. Prerequisite: Plant Pathology 317. GERDEMANN.

POLITICAL SCIENCE

The Department of Political Science offers graduate work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work is conducted in the following special fields: American government and politics, comparative government and politics, international law and relations, public administration, political theory and jurisprudence. A separate program leading to the degree of Master of Arts in Public Administration is administered by the department and is described below.

In order to be admitted to graduate work in political science a student must have a grade-point average of at least 3.75 for that portion of the work which represents the last 50 per cent of the hours earned for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. They must also have had a minimum of twenty hours of undergraduate work in political science, economics, sociology, and history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history). If a student making political science his major is taking both of his minors in other departments, one of them must be in history, economics, or sociology.

Several courses given in other departments are so closely related to those in political science that graduate students whose major is political science may be permitted on petition to take such courses as part of their major work. Attention is called to the courses in public law in the College of Law, the courses in public finance in the College of Commerce and Business Administration, the courses in city and regional planning in the College of Fine and Applied Arts, and the courses in municipal and sanitary engineering in the College of Engineering. An extension curriculum in public administration leading to the Master of Arts degree

is offered at Springfield, Illinois. This curriculum is designed particularly as in-service training for persons in the various state services.

Graduate students in other departments who choose political science as a minor must have had at least six hours of undergraduate work in political science and three hours in economics, sociology, or history.

Degree of Master of Arts in Public Administration. The chief purpose of the program leading to this degree is to enable persons from a wide variety of undergraduate specializations to take advanced work in the general field of public administration. It supplements undergraduate training in arts, sciences, or the professions with the specialized knowledge and skill in the field of public administration required for many positions in the public service of state, local, and national governments in the United States. To be admitted to the Graduate College as a candidate for this degree, the applicant must have a bachelor's degree from an accredited institution and an undergraduate grade average of 3.75 for that portion of the work which represents the last 50 per cent of the hours earned for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. Undergraduate specialization may have been in any recognized field useful as preparation for governmental employment. Admissibility further depends on showing that the candidate has a well worked out plan for some type of governmental employment and that he will have acquired the skills and knowledge needed by the end of approximately a year's graduate study. Those persons who do not have a reasonable background in government and politics in the United States, who show marked deficiencies in oral and written English, or who lack an elementary knowledge of statistical and accounting procedures commonly used in government may be admitted but are required to take non-credit work to correct the deficiency. Wherever possible candidates are interviewed before being formally admitted to this program.

The program of study, aside from the making up of deficiencies, is a flexible one made up each semester in consultation with the adviser. Eight units of work are required, of which two are ordinarily earned by the writing of a master's thesis. Other courses depend upon the candidate's background and specialization, but include as a minimum a two-semester general seminar in public administration (two units), and one-half to one unit of work each in public personnel administration, public fiscal administration, public finance, and administrative law. Finally, persons without experience in government employment, after completion of their academic work are required to complete successfully an internship of at least three months. Paid internships are arranged wherever possible. At the end of the internship and when the thesis is submitted there is an examination, oral and written, on the work completed.

FELLOWSHIPS AND ASSISTANTSHIPS

The James Wilford Garner Fellowship in Political Science, carrying a stipend of $1,500, was established in 1951 by a gift to the University from Mrs. Garner as a memorial to Professor Garner, who served as head of the Department of Political Science from 1904 to 1938.

Professor John A. Fairlie, who served on the political science faculty from 1909 to 1941, bequeathed to the University a sum of money the income from which is used to provide the John A. Fairlie Fellowship in Political Science carrying a stipend of $1,500.

The department participates with the Department of History in the Kendric C. Babcock Fellowship established under the will of Dean Kendric C. Babcock. For the third year these appointments carry a stipend of $1,500, and postdoctoral grants carry a stipend of $2,400. Nominations for these fellowships are made by the chairmen of the Departments of Political Science and History.

Application forms for these fellowships may be obtained from the Graduate College.

The department has available a certain number of teaching assistantships which carry the requirement of six hours of teaching a week in elementary sections. Students must have received the master's degree to be considered for these positions. Correspondence regarding them should be addressed to the chairman of the department, 324 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: F. G. Wilson (Chairman of Department), C. A. Berdahl, R. Dangerfield, C. B. Hagan, V. Jobst, C. M. Kneier, E. G. Lewis, C. F. Snider.

Associate Professors: J. M. Edelman, P. Monypenny, J. W. Peltason, J. A. Ranney.

Assistant Professors: G. Manner, T. Page, R. E. Scott.

COURSES FOR GRADUATES

400. **Classics of Political Science.** Reading, analysis, and discussion of leading works on politics and government. I or II; 1 unit. Staff.

401. **History of Political Theories.** Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. I; 1 unit. Wilson.

402. **History of Political Theories.** Reading and analysis of the leading political thinkers from the middle of the seventeenth century to the present. II; 1 unit. Wilson.

406. **Municipal Administration.** Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. I or II; 1 unit. Kneier.

410. **Problems in Rural Local Government.** Research in selected topics. I or II; 1 unit. Snider.

412. **Problems in State Government.** Research in selected topics in American state government. I or II; 1 unit. Snider.

420. **Formation of Public Policy.** Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. I or II; 1 unit. Hagan.

421. **Government and the Economic Order.** Same as Mass Communications 421. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. I or II; 1 unit. Hagan.

426. **Political Parties.** Special problems in political parties; methods and materials of research in this field. I or II; 1 unit. Berdahl.

431. **Problems of British Government.** Special topics relating to British government. I or II; 1 unit. Lewis.

450. **Contemporary Governmental Problems.** Special problems of current importance. Designed especially for students not majoring in political science. S; 1 unit.

451. **Constitutional Law.** Research in selected topics in the American constitutional system. I; 1 unit. Prerequisite: Political Science 351 or equivalent. Peltason.

465. **Problems in Administrative Management.** An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. I or II; 1 unit. Prerequisite: Political Science 361 or 364, or consent of instructor. MONYPENNY.

466. **Current Administrative Theory.** A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. I or II; 1 unit. MONYPENNY.

471. **Problems in International Organization.** Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. I or II; 1 unit. BERDAHL.

481. **Foreign Relations of the United States.** Special problems in the development and conduct of American foreign policy. I or II; 1 unit. DANGERFIELD.

485. **International Law.** Research in selected topics. I or II; 1 unit. JOBST.

491. **Seminar in Political Science and Public Law.** Theses, special problems, reports, discussions, and criticism. I, II; ½ to 4 units. STAFF.

493. **Research in Selected Topics.** Research in selected topics by arrangement with the instructor. I, II; 1 unit. STAFF.

499. **Scope and Methods of Political Science.** Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; techniques for selecting research problems, collecting and interpreting data, and reporting results; the present state of research in political science. I or II; 1 unit. DANGERFIELD.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Municipal Government.** Growth of cities; their legal status; municipal politics and organization in the United States. I; ½ to 1 unit. KNEIER.

306. **Municipal Problems.** Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. II; ½ to 1 unit. KNEIER.

310. **Rural Local Government.** Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. I or II; ½ to 1 unit. SNIDER.

312. **State Government.** The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; reorganization problems in the state; state-local relations; state finance; trends and prospects. Students may not receive credit for both Political Science 110 and 312. I or II; ½ to 1 unit. SNIDER.

315. **Legislatures and Legislation.** The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and

lobbying; relation of legislature to other branches of government; problems of legislative reorganization. I or II; ½ to 1 unit. HAGAN.

321. **Government and the Economic Order.** A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. I; ½ to 1 unit. HAGAN.

325. **Political Parties: Historical Development and Issues.** Nature of American party system; historical development of parties and issues; third or minor parties and their role. I or II; ½ to 1 unit. BERDAHL.

326. **Political Parties: Organization and Methods.** Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. I or II; ½ to 1 unit. BERDAHL.

328. **Political Behavior: The Electoral Process.** A study of the principal characteristics of and influences upon voting behavior in the United States; methods for studying voting behavior and predicting elections; analysis of present alignments in the electorate as revealed by recent elections. I or II; ½ to 1 unit. RANNEY.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. I or II; ½ to 1 unit. LEWIS.

336. **Continental European Governments and Politics.** An analysis of the major political systems of continental Europe; constitutional and legal structures of France, Germany, Italy, the Soviet Union, and Spain; factors in the struggle for power; political and social movements as they affect the European scene; relation of political to economic, religious, and social institutions in Europe. II; ½ to 1 unit. LEWIS.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin-American political institutions; systems of government; public administrative systems; party government; international policies of Latin-American governments. I or II; ½ to 1 unit. SCOTT.

343. **International Relations of Latin America.** Latin-American position and objectives in international affairs, with emphasis on the Latin-American viewpoint; the Monroe Doctrine; the Good Neighbor Policy; the organization of American states and the United Nations; recent relations of specific nations. I or II; ½ to 1 unit. SCOTT.

345. **Theory and Practice of Democratic Government.** Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. I or II; ½ to 1 unit. RANNEY.

346. **Theory and Practice of Communism.** A survey of the international communist movement. The origins of modern communism and the nineteenth century development of its doctrines; the Russian Revolution; Lenin and Stalin; the U.S.S.R. as a model for communism; the regional development of Communist Parties. Students do not receive credit for both Political Science 346 and 396. I or II; ½ to 1 unit. WILSON.

351. **American Constitutional System.** Judicial interpretation of the constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. I; ½ to 1 unit. PELTASON.

354. **The Constitution and Industrial Legislation.** Scope of national regulatory power; commerce clause, taxing power; spending power; scope of state regulatory power; police power and due process limitations. II; ½ to 1 unit. PELTASON.

355. **The Constitution and Civil Liberties.** A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. I or II; ½ to 1 unit. PELTASON.

356. **Administrative Law in the United States.** A study of the powers of administration, of the legal requirements for and the limits on the exercise of such powers, of the internal and external means of safeguarding individual rights, and of the enforcement of the responsibility of administrative officers both politically and legally. II; ½ to 1 unit. MONYPENNY.

359. **Jurisprudence.** Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. I or II; ½ to 1 unit. MANNER.

361. **Introduction to Public Administration.** Development of administrative organizations; administration and the executive, legislature, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. I; ½ to 1 unit. MONYPENNY.

364. **National Administration.** Creation and development of the national administrative organization; the executive departments; regulatory, service, and staff agencies; special organization for emergency and war; efforts at reorganization and coordination. I or II; ½ to 1 unit. MONYPENNY.

365. **Theory and Administration of Federal Labor Law.** Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. I or II; ½ to 1 unit. EDELMAN.

367. **Public Fiscal Administration.** The public budget process in representative governmental units: preparation and control, the budget as a tool of policy, audit functions, supply services, claim settlement, fund and debt management, relation to organization and methods analysis and personnel utilization, and intergovernmental fiscal relations. I or II; ½ to 1 unit. PAGE.

368. **Public Personnel Administration.** Same as Labor and Industrial Relations 368. An analysis of personnel management in government. Recruitment and selection, job and salary classification, work standards, training, and the role of labor and professional organizations in the public services are considered in the light of current theory and practice. I or II; ½ to 1 unit. PAGE.

371. **International Organization.** General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the League of Nations, the United Nations, and related agencies. I or II; ½ to 1 unit. BERDAHL.

372. **International Organization.** The problem of war and security; pacific settlement of disputes; the functioning of the United Nations and other international agencies in respect to economic and social problems. I or II; ½ to 1 unit. BERDAHL.

381. **American Foreign Relations.** Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty making power; development of foreign policy. I or II; ½ to 1 unit. DANGERFIELD.

382. **Contemporary American Foreign Policies.** Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. I or II; ½ to 1 unit. DANGERFIELD.

384. **International Relations.** An examination of the nature of the national state system, of the forces affecting international relations, of the sources of conflicts in international politics, and of their solution by power politics or by international cooperation. I or II; ½ to 1 unit. MANNER.

385. **International Law.** Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. I; ½ to 1 unit. JOBST.

386. **International Law.** Responsibility, intercourse, and redress of differences between states. II; ½ to 1 unit. JOBST.

393. **History of Political Theory.** A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of Christian political thought and the Middle Ages; political theory during the Renaissance, Reformation, and Counter-Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, Utopianism, and socialism. I or II; ½ to 1 unit. WILSON.

396. **Contemporary Political Theory.** Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; anti-democratic thought and totalitarian regimes. Students may not receive credit for both Political Science 396 and 346. I or II; ½ to 1 unit. WILSON.

397. **American Political Theory.** A survey of American political thought from colonial times to the present. I; ½ to 1 unit. Offered in 1957-1958 and in alternate years. WILSON.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Fields. Doctoral programs are offered in the following special areas of psychology: general experimental psychology, personality, social psychology, psychometrics, clinical psychology and counseling, human engineering, industrial psychology, school psychology.

Admission. In addition to the general requirements of the Graduate College, the candidate for admission to graduate study in psychology must meet the following undergraduate requirements: (1) a minimum of fifteen semester hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) one course in another laboratory science; (4) a grade-point average of at least 4.0 in courses representing the last 50 per cent of the hours completed for the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. Preference is given to students who have taken mathematics and two years of French or German. These are minimal requirements. Because it is necessary to limit the number of admissions to graduate study in psychology, it is not possible to accept all applicants who meet the minimal requirements.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The degree of Master of Arts is awarded to candidates who complete satisfactorily eight units of course work and present an acceptable thesis.

Programs for the degree of Doctor of Philosophy are normally organized under the department's designated fields of specialization, but individual programs may be arranged to meet the special needs of students. Such special programs usually are planned at the end of the first year.

In the fields of general experimental psychology, personality, social psychology, and psychometrics, the degree of Doctor of Philosophy is awarded to students who (1) complete satisfactorily the standard area program including the minors and electives, a minimum of sixteen units; (2) pass all examinations required by the Graduate College and by the Department of Psychology; and (3) present an acceptable doctoral thesis, based upon the equivalent of at least eight units of work.

In the fields of clinical psychology and counseling, human engineering, industrial psychology, and school psychology, the doctoral candidate must meet the three general classes of requirements just described. In addition, he must complete one full year of internship or field work in an agency approved by the Department of Psychology. Normally this work is done in the student's third year of graduate study. With special departmental approval the internship requirement may be met in the fourth year, following the completion of the other doctoral requirements.

The special doctoral program for the training of school psychologists is offered jointly by the Department of Psychology and the College of Education. Students may enroll in either department for this program, which is administered by the Joint Committee on School Psychology.

FELLOWSHIPS AND ASSISTANTSHIPS

The Department of Psychology appoints each year a substantial number of part-time teaching and research assistants. Information concerning assistantships may be secured from the head of the Department of Psychology, 314 Gregory Hall.

Graduate students in psychology may apply for University fellowships which are awarded by the Graduate College. Application must be filed with the Dean of the Graduate College before February 15 of the academic year preceding that for which the fellowship is desired. (See page 29).

In the field of clinical psychology, three special kinds of financial aid are available: (1) full-time internships in the Psychological Clinic for third-year and fourth-year graduate students; (2) traineeships provided by the United States Public Health Service; (3) part-time traineeships of the United States Veterans Administration, with stipends varying with the Civil Service classification of the trainee and the amount of time spent in the Veterans Administration hospital. Additional information can be secured from the head of the Department of Psychology, 314 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: L. H. Lanier (Head of Department), R. B. Cattell, W. M. Gilbert, G. D. Higginson, J. M. Hunt, W. E. Kappauf, L. L. McQuitty, O. H. Mowrer, L. I. O'Kelly, C. E. Osgood, R. Stagner, P. T. Young.

Associate Professors: J. Cohen, C. W. Eriksen, T. N. Ewing, F. E. Fiedler, G. R. Grice, L. A. Hellmer, Alice K. Jonietz, W. G. McAllister, H. Rosen.

Assistant Professors: N. H. Eisen, D. R. Peterson, I. D. Steiner, D. L. Thistlethwaite.

Instructors: W. C. Becker, D. J. Shoemaker.

COURSES FOR GRADUATES

The prerequisites stated are appropriate for graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all of the prerequisites.

401. **History of Psychology.** I or II; 1 unit. Prerequisite: Twelve hours of psychology. GRICE.

402. **Systematic Psychology.** A critical analysis and comparison of modern and contemporary psychological systems. I or II; 1 unit. Prerequisite: Psychology 401. LANIER.

406. **Quantitative Methods, I.** A lecture and laboratory course in the development and application of quantitative methods in psychological research. I; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. KAPPAUF.

407. **Quantitative Methods, II.** Continuation of Psychology 406. II; 1 unit. Prerequisite: Psychology 406. KAPPAUF.

411. **Advanced Physiological Psychology.** Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation, learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. O'KELLY.

415. **Experimental Sensory Psychology.** A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. COHEN.

417. **Experimental Psychology of Learning, I: Basic Processes.** A study of experimental investigation of basic learning processes with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. I; 1 unit. Prerequisite: Twelve hours of psychology. GRICE.

418. **Experimental Psychology of Learning, II: Human Learning.** Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. II; 1 unit. Prerequisite: Psychology 417 or consent of instructor.

419. **Advanced Comparative Psychology.** A critical examination of specific techniques used and of representative results obtained in the study of animal behavior. Laboratory demonstrations and individual research problems. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 345 or equivalent. MCALLISTER.

421. **Problems in Motivation.** I or II; 1 unit. Prerequisite: Twelve hours of psychology. YOUNG.

426. **Experimental Psychology of the Communication Process.** Same as Mass Communications 426. A critical survey of methods and theories in the psychological study of the communication process, with emphasis upon the development of symbolic behavior, experimental semantics, and frequency studies. Application is made to various problems in social science. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology or equivalent. OSGOOD.

431. **Personnel Psychology in Business and Industry.** The application of psychological principles and procedures to personnel methods in industry and business. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 and 290 or equivalent. MCQUITTY.

433. **Research Methods in Personnel and Industrial Psychology, I.** Survey and critical appraisal of the application of research methods to personnel and industrial problems. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406, 407, and 431, or equivalent.

434. **Research Methods in Personnel and Industrial Psychology, II.** Continuation of Psychology 433. II; 1 unit. Prerequisite: Psychology 433.

437. **Psychogenics of Industrial Conflict.** Same as Labor and Industrial Relations 437. Offers an opportunity for advanced study, through readings in current literature, lectures, field projects, and visiting speakers, of the psychological origins of industrial conflict. Theoretical analysis of the perceptions, emotions, motives, and frames of reference of managerial executives, workers, and union officials is supplemented by visits to industrial enterprises and union headquarters. Each student is required to do an intensive library and field study of some specific problem in labor-management relations. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 357 or equivalent. ROSEN, STAGNER.

441. **Personality Dynamics.** Systematic study of the structure of personality, the basic principles of behavior dynamics, and the determinants of personality development. I; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 338 or equivalent. HUNT.

442. **Behavior Disorders.** A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. II; 1 unit. Prerequisite: Psychology 441 or equivalent. PETERSON.

443. **Psychodiagnostics, I.** Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and achievement. I; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 290 or equivalent.

444. **Psychodiagnostics, II.** Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. II; 1 unit. Prerequisite: Psychology 443; consent of instructor.

445. **Psychodiagnostics and Psychotherapy, I.** Provides didactic training and supervised experience in psychodiagnostics and psychotherapy. Students are required to enroll concurrently in Psychology 463-464, as a means of relating the practicum experience with the study of research methodology. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 441, 442, 443, and 444; consent of instructor. GILBERT, HELLMER, JONIETZ, SHOEMAKER.

446. **Psychodiagnostics and Psychotherapy, II.** Continuation of Psychology 445. II; 1 unit. Prerequisite: Psychology 445; consent of instructor. GILBERT, HELLMER, JONIETZ, SHOEMAKER.

451. **Advanced Social Psychology.** A systematic and critical treatment of individual behavior variables in relation to group variables. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 255 or equivalent. STEINER.

455. **The Measurement of Attitude and Opinion.** Same as Mass Communications 455. A systematic study of scaling and sampling methods in social psychology, with accompanying laboratory work and practice in methods of analyzing data. Recent developments in theory and methods of attitude scaling are emphasized. I or II; 1 unit. Prerequisite: Psychology 406 or equivalent. THISTLETHWAITE.

456. **Psychology of Social Communication.** Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. I or II; 1 unit. Offered in 1957-1958 and in alternate

years. Prerequisite: Psychology 451 or equivalent, or consent of instructor. THISTLETHWAITE.

457. **Social Perception and Interpersonal Relations.** The genesis and development of social perception, with emphasis upon the concept of the "self" and its role in social perception; motivational factors in social perception; interpersonal perception, and its effects upon individual and group behavior. I or II; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Psychology 451 or equivalent. FIEDLER.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision-making, group cohesiveness, and productivity. I or II; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Six units of graduate credit in psychology, including Psychology 451 or equivalent. STEINER.

459. **Leadership and Group Effectiveness.** Theories of leadership; methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. I or II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Psychology 451 or equivalent. FIEDLER.

461. **Developmental Psychology.** Theory and research on psychological development from birth through adolescence; maturation of behavior systems; the role of social learning in development; the effects of early experience on personality development; critical stages in development. I or II; 1 unit. Prerequisite: Twelve hours of psychology or consent of instructor. HUNT.

463. **Research Methods in Clinical Psychology and Personality, I.** The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406, 407, 441, 443, and 444. HUNT.

464. **Research Methods in Clinical Psychology and Personality, II.** Continuation of Psychology 463. II; 1 unit. Prerequisite: Psychology 463. HUNT.

465. **Factor Analysis in Psychology.** The psychological theory and the procedures of factor analysis, including factoring, rotation, the psychological nature of factors, and the place of factor analysis in science. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406 and 407 or equivalent.

466. **Test Construction.** A systematic development and critical consideration of the theories, methods, and techniques in test construction. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406 and 407 or equivalent. MCQUITTY.

467. **Personality Theory.** A survey of major theories regarding human personality, the key concepts in these theories, and the relation between theory and research findings on personality. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 441 or equivalent. STAGNER.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories concerning the learning process, including the work of Hull, Tolman, and Guthrie. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 401 and 402. GRICE.

469. **Scientific Method in Psychology.** An analysis of the general nature of scientific inquiry, with special reference to the logic of contemporary psychology. Consideration is given to the nature and use of psychological concepts; hypothesis and deduction; experimental methodology; the construction of

psychological theory. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 401 and 402. LANIER.

483. **Seminar in Psychology of Speech Disorders.** Same as Speech 483. Advanced theoretical study of psychological disorders of speech such as stuttering, delayed speech, and hysterical conditions; survey of current theory and research. I or II; 1 unit. Prerequisite: Consent of instructor.

490. **Individual Research.** For graduate students who wish to conduct research on special problems not included in graduate theses. I, II; ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

491. **Research and Thesis (A.M.).** I, II; ½ to 2 units. STAFF.

492. **Research and Thesis (Ph.D.).** I, II; ½ to 4 units. STAFF.

493. **Research Seminar.** Discussion of current topics in their historical setting with special emphasis on research problems. I, II; ½ to 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 401, 402, 406, and 407; consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Physiological Psychology.** A study of the physiological basis of behavior including sensory processes, motivation, emotion, learning, and intelligence. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology; Physiology 105 or 106, or Zoology 101. O'KELLY.

326. **Motivation and Emotion.** The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology. YOUNG.

330. **Advanced Experimental Psychology.** A survey of experimental techniques and subject matter in the fields of psychophysics and measurement, sensory processes, attention and perception, motivation and emotion, learning and memory, and motor activity. Lectures and laboratory. I, II; ½ to 1 unit. Prerequisite: Psychology 100 or 103; a course in statistics. COHEN.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology. BECKER, PETERSON.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. I or II; ½ to 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. MCALLISTER.

348. **The Psychology of Learning.** A survey of the basic facts and theories of the learning process. Credit is not allowed for both Psychology 348 and 352. I or II; ½ to 1 unit. Prerequisite: Six hours of psychology. GRICE.

351. **Advanced General Psychology, I.** An intensive survey of sensory processes, perception, and behavior development, with emphasis on the relation of facts to contemporary theories. I; ½ to 1 unit. Prerequisite: Six hours of psychology. KAPPAUF.

352. **Advanced General Psychology, II.** An intensive survey of motivation, emotion, learning, symbolic processes, and individual differences, with emphasis on the relation of facts to contemporary theories. Credit is not allowed for both Psychology 348 and 352. II; ½ to 1 unit. Prerequisite: Six hours of psychology. OSGOOD.

357. **Psychology of Industrial Conflict.** Same as Labor and Industrial Relations 357. An analysis, in terms of the behavior of individuals, of the causes and

possible solutions of industrial conflict. I or II; ½ to 1 unit. Prerequisite: Psychology 100 or equivalent; Psychology 245, Economics 240, or Sociology 318. ROSEN, STAGNER.

SOCIAL SCIENCES

A special program leading to the degree of Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including economics, geography, history, philosophy, political science, psychology, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 3.5 for that portion of the work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training, and must be acceptable to the adviser for the program. Students are admitted on limited status.

The degree of Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work which are mandatory for the major. At the completion of his studies the student must pass an examination covering the studies and held by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor B. J. Diggs, 125 Lincoln Hall. The general adviser for this degree is Professor C. B. Hagan, 301 Lincoln Hall.

Candidates for the degree of Master of Arts in the Teaching of Social Studies must earn four units in social studies, three units in education, and one unit in electives. Requirements are (1) social studies selected from not more than three of the following: economics, geography, history, at least two units; philosophy, political science, sociology, four units; (2) two of the following courses: Education 301, 302, 303, 304, one unit; Education 311 and 312, one unit; and Education 456, one unit. The courses in social studies and the electives must be selected with the approval of the adviser. The electives may be in the social studies, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the division. Students are not admitted to the program on limited status.

The adviser for candidates for this degree is Professor J. W. Swain, 325 Lincoln Hall.

SOCIAL WORK

The School of Social Work offers two years of graduate professional study leading to the degree of Master of Social Work. Although the basic curriculum of the school is the same for all students, there are opportunities for specialization in case work and group work. Students specializing in group work have their classes at Navy Pier in Chicago and field placements in group work agencies in the city. Those specializing in case work have their first-year academic work in Urbana and field placements in selected agencies in or near Champaign-Urbana. The second-year case work may be in either Urbana or Chicago.

The school has established an admissions committee which is responsible for

reviewing all applications. The committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and pre-professional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. Although no specific undergraduate grade-point average is specified, the applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Preference is given to applicants between the ages of twenty-one and thirty-five, but consideration is given to older applicants who have demonstrated their capacity for social work practice. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthy relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

Because of the limited number of field work placements in acceptable social agencies, the school is compelled to limit its enrollment to the number of field work placements available.

Application must be made to the School of Social Work. The special bulletin issued by the school may be obtained by writing to the Director, School of Social Work, 1204 West Oregon Street.

FELLOWSHIPS AND ASSISTANTSHIPS

A number of public and private agencies offer fellowships. Some of these involve commitment to enter agency employment upon completion of a year or more of graduate study. Information may be obtained from the school.

A limited number of part-time assistantships are available for second-year students who have demonstrated academic ability and skills needed in research or other assignments. Application should be made to the director of the school, 1204 West Oregon Street.

GRADUATE TEACHING FACULTY

Professors: Marietta Stevenson (Director of School of Social Work) Florence L. Poole.

Associate Professors: R. J. Artigues, Jennette Gruener, Margaret Holden, Edith L. Nagel, W. Schwartz, W. P. Simon.

Assistant Professors: J. E. McDonald, Mary E. Reese, D. Katharine Rogers.

Lecturers: H. H. Fineberg, L. Hellmer, M. Krugly, J. D. McKinney, Maria Piers, M. Samter, Cleone Truitt, H. C. Wood, Carle Clinic Physicians.

COURSES FOR GRADUATES

421. Social Work Methods, I. A course in the principles and practice of social work integrating classroom and field instruction. Sections A1 and A2 are required of all students. In addition, Sections B1 and B2 are required of case work majors and Sections C1 and C2 of group work majors. I; 2 to 4 units.

Section A1. Social Work Theory. This section includes consideration of the underlying philosophy and concepts on which social work is based; generic principles of social work method which are applicable to all areas of social work practice; role of the social worker in helping individuals and groups

basic elements in recording, budgeting, programming; case work-group work interrelationships; referrals. One hour weekly. NAGEL, POOLE, SIMON.

Section A2. Research. The purpose of this section is to acquaint the student with the major sources of statistical data needed by the social worker, and to help him acquire facility in the use of such data. Students read and interpret simple statistical materials and apply simple statistical methods to social work material. One hour weekly. GRUENER.

Section B1. Social Case Work. The purpose of this section is to help the student use the basic principles of social work in the practice of social case work. Through discussion of case material from various settings and from his own field experiences the student is helped to understand the social case work process and to use this understanding in helping the client. Two hours weekly. NAGEL.

Section B2. Field Instruction in Social Case Work. Instruction is based on the student's own practice and is designed to help him develop skill in social case work. The student is assigned to a social agency where he has responsibility for carrying selected cases under the supervision of a qualified field instructor. NAGEL and field instructors.

Section C1. Social Group Work. The purpose of this section is to help the student use the basic principles of social work in the practice of social group work. Discussion is focused on helping the student understand the dynamics of the group process and the meaning of program activities and to use this understanding to help the individual and the group develop a capacity for creative and effective relationships. Record material is used as the basis for discussion. Two hours weekly. SIMON.

Section C2. Field Instruction in Social Group Work. Instruction is based on the student's own practice and is designed to help him develop skill in social group work. The student is assigned to a social agency where he has responsibility for direct work with selected groups under the supervision of a qualified field instructor. SIMON and field instructors.

422. **Social Work Methods, II.** This course includes a more extensive analysis and application of the principles of case work and group work and the introduction of the social work process in community organization. Sections A1 and A2 are required of all students. In addition, Sections B1 and B2 are required of case work majors and Sections C1 and C2 of group work majors. II; 2 to 4 units. Prerequisite: Social Work 421.

Section A1. Community Organization. This section is designed to help the student understand the community organization process at the neighborhood, city, state, and federal levels, with special emphasis on social work method in planning, coordinating, and helping the community to use health, welfare, and leisure-time services. Content is presented through lecture-discussion method, group study projects, and examination of process records. One hour weekly. NAGEL, POOLE, SIMON.

Section A2. Research. The purpose of this section is to acquaint the student with the aims and methods of research in social work. Illustrative studies are analyzed. Basic principles in planning and carrying out studies of various types are considered in preparation for the second-year research project. One hour weekly. GRUENER.

Section B1. Social Case Work. This section, a continuation of Social Work 421 B1, is designed to help the student increase his knowledge and improve his skill in the practice of social case work. Two hours weekly. NAGEL.

Section B2. Field Instruction in Social Case Work. A continuation of the first semester of field instruction. Two days weekly. NAGEL and field instructors.

Section C1. Social Group Work. This section, a continuation of Social Work 421 C2, is designed to help the student increase his knowledge and improve his skill in the practice of social group work. Two hours weekly. SIMON.

Section C2. Field Instruction in Social Group Work. A continuation of the first semester of field instruction. Two days weekly. SIMON and field instructors.

423. Social Work Methods, III. This second-year course includes further emphasis on the student's understanding and skill in social work with broader consideration of practice in various settings. Section A1 is required of all students. In addition, Sections B1 and B2 are required of case work majors and Sections C1 and C2 of group work majors. I; 2 to 4 units. Prerequisite: Social Work 422.

Section A1. Social Work Settings. This section is designed to help students examine and understand the use of social work method in different settings. The student is helped to develop ways of determining the nature and content of social work services in various settings and methods of developing collaborative working relationships with other services in the setting. Consideration is given to some of the content specific to various kinds of agencies in which social work is practiced. One hour weekly. POOLE.

Section B1. Social Case Work. This section is designed to broaden and deepen the student's understanding of social case work and to help him increase his skill in practice. Consideration is given to both short-time and continuing relationships and to the integration of social work service with the services of other disciplines. Case material from various settings is introduced by the instructor and students. Two hours weekly. POOLE.

Section B2. Field Instruction in Social Case Work. In the third semester of field instruction the student's assignment is in a setting different from that of the first year. Three days weekly. HOLDEN, POOLE, and field instructors.

Section C1. Social Group Work. The use of the social group work method is discussed with particular attention to the social group work process as related to variations in type, size, and purpose of group. Special consideration is given to advanced material in use of program content and to the role of the group worker in departmental program planning. Two hours weekly. SCHWARTZ.

Section C2. Field Instruction in Social Group Work. In the third semester of field instruction the student's assignment includes more complex group problems and elementary administrative and supervisory responsibilities. Emphasis is placed on widening and deepening the student's skill in practice as represented in advance use of program, relationship of group achievement to agency purpose, departmental program planning, and supervision of group leaders. Three days weekly. SCHWARTZ and field instructors.

424. Social Work Methods, IV. A continuation of Social Work Methods III with the addition of specific material on methods of supervision and administration in social work. Section A1 is required of all students. In addition, Sections B1 and B2 are required of case work majors and Sections C1 and C2 of group work majors. II; 2 to 4 units. Prerequisite: Social Work 423.

Section A1. Supervision and Administration. The focus of this section is the social work process in administration and supervision. Supervisory and administrative responsibilities are examined to determine the basic elements of each and the nature of the relationships involved. Criteria and methods for evaluation are discussed. Illustrative case material is used. One hour weekly. SIMON.

Section B1. Social Case Work. This section is a continuation of Social Work 423 B1 with additional emphasis on presentation by students of material

drawn from their own practice. The student is helped to identify his own developing skill and to examine and work on areas in which he needs further development. Two hours weekly. POOLE.

Section B2. Field Instruction in Social Case Work. A continuation of the third semester of field instruction. Three days weekly. HOLDEN, POOLE, and field instructors.

Section C1. Social Group Work. This section includes further discussion of principles and practice in social group work with emphasis on the student's ability to present, analyze, and evaluate material from his own practice. Two hours weekly. SCHWARTZ.

Section C2. Field Instruction in Social Group Work. A continuation of the third semester of field instruction rounding out the student's agency field experience and emphasizing his growing skill as a social group worker. Three days weekly. SCHWARTZ and field instructors.

451. **Dynamics of Human Development, I.** This course is designed to increase the student's understanding of the development of the individual. Integrated material from the fields of medicine, psychiatry, psychology, and anthropology is presented. Emphasis is placed on changes which the individual undergoes as he moves through life. Lectures are presented by representatives of other professions. Discussion of the social worker's use of this material is led by the social work instructor. I; 1 to 2 units. HOLDEN, NAGEL, and lecturers.

453. **Dynamics of Human Development, III.** Medical information is presented concerning major infectious and chronic diseases, and mental disorders caused primarily by infectious agents. The interrelationship of the physical and emotional aspects of the causation and management of the diseases is discussed. Consideration is given to environmental factors influencing these diseases, and the resources of the community for control programs. The social aspects of illness and medical care, the meaning of illness to the individual and his family, and methods of helping the patient use health and medical facilities are included throughout the course. Instruction is shared by physicians and a member of the social work faculty. I; 1 to 2 units. Prerequisite: Social Work 451. HOLDEN, REESE, and lecturers.

454. **Dynamics of Human Development, IV.** In this course there is discussion of the dynamics of neuroses and psychoses, and the social implications of these disorders. Emphasis is on the emotional reactions manifested as a result of the individual's attempt to maintain a functioning balance. Discussion is based on student's material from various settings, and on material presented by the instructors. Instruction is shared by a psychiatrist and a member of the social work faculty. II; 1 to 2 units. Prerequisite: Social Work 451. HOLDEN, REESE, and lecturers.

461. **Special Studies in Social Work, I.** Independent or group study in areas of special interest, application of social work principles to special problems or settings. I, II; 1 to 2 units. STAFF.

462. **Special Studies in Social Work, II.** Independent or group study in areas of special interest, application of social work principles to special problems or settings. I, II; 1 to 2 units. STAFF.

481. **Social Welfare Organization, I.** A course covering the current services and organization for social welfare with emphasis on the political, social, and economic forces giving rise to their development. Attention is given to the English and early American experiences, to the emerging specialized services, and to the contribution of private philanthropy; the expansion of public responsibility from local to state to state-federal; basic legal concepts; the impact of the war economy on the social services; and the expansion of

American social welfare activities in foreign countries and in the United Nations Organization. I; 1 to 2 units. ARTIGUES.

482. **Social Welfare Organization, II.** A study of the principles and content of the programs for income maintenance, health and medical care, family counseling, child welfare, and informal education. Consideration is given to social insurance, work relief, employment services, labor standards, and public assistance, with focus on basic premises, content, and objectives, and on the function each performs in maintaining minimum protection against economic want. Both public and private service programs are examined in their relation to the prevention and treatment of incapacity and in the restoration of social functioning of individuals and groups. II; 1 to 2 units. Prerequisite: Social Work 481. ARTIGUES.

483. **Social Welfare Organization, III.** An analysis of organizational patterns and of the administrative process. The structures of national, state, and local public and private agencies are analyzed from the point of view of their respective functions and interrelationships and of the influence exerted on them by American political and cultural ideologies. The administrative process is reviewed through examination of policy formulation, the executive function, organization, coordination, authority, field services, personnel, budgeting, and public relations. Social action and the legislative process are reviewed in their relations to agency policy and objectives. I; 1 to 2 units. Prerequisite: Social Work 482. ARTIGUES, STEVENSON.

484. **Social Welfare Organization, IV.** Consideration is given to the integration of the social services through coordinated planning as reflected in both governmental and voluntary planning agencies. The role of research is examined. Current developments and issues are examined, such as the role of social service in our society, the economics of social service, the respective roles of public and private services, and the relationships of the income maintenance programs to each other. II; 1 to 2 units. Prerequisite: Social Work 483. ARTIGUES, STEVENSON.

491. **Research.** A seminar for students working on a group research project providing experience in the application of research methods to current social welfare material. Each student is expected to assume responsibility for one phase of the total investigation. With the approval of the faculty research committee, a student with special qualifications may work on an individual project in lieu of a group project. Required of all students. I, II; 0 to 2 units. GRUENER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Introduction to Social Case Work.** This course for employed workers deals with the behavior and attitudes expressed by persons asking for assistance, the feelings thus engendered, and the effects of all of these on the contacts of social case workers with individuals and families. Attention is given to case records selected from social case work practice in public assistance and other community agencies. I, II; ½ unit. MCDONALD.

316. **Social Services for Children.** This course is designed to acquaint students with the unmet needs of children and the organization of social services to meet those needs. Responsibilities of voluntary as well as public agencies are considered. A survey is made of agencies providing leadership and standard setting in social services for children. I, II; ½ to 1 unit. Prerequisite: Consent of instructor. ROGERS.

333. **Introduction to Social Group Work.** This course is designed to present background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development

of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustration from the field of practice in informal education, recreation, and social group work. I; ½ unit. Prerequisite: Introductory courses in sociology, psychology, social sciences. ROGERS.

SOCIOLOGY AND ANTHROPOLOGY

The Department of Sociology and Anthropology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy in Sociology and Master of Arts in Anthropology.

Sociology

The basic program of graduate study for all students taking sociology as a major subject consists of a collection of courses designed primarily to give the student a broad training in the principles and in the fundamentals of theory, scientific methodology, and research techniques in the general field of sociology. All students are required to take courses in these areas selected in consultation with the adviser. In addition to the basic program, the department offers opportunities for students to specialize in any one of several fields within the discipline, including rural sociology. Specialized training to meet the particular needs of each student may be arranged through the selection of appropriate courses with the aid of the adviser, through supervised individual work on special topics, and through the research performed in connection with the preparation of the dissertation.

A student intending to offer sociology as a minor in connection with a major in some other field must have had at least six hours of undergraduate work in sociology, and should consult with the chairman of the department before registering for courses.

In order to be admitted with full standing, students intending to elect sociology as their major must fulfill the general requirements of the Graduate College and must meet the following departmental requirements: (1) a minimum of nine semester hours of undergraduate work in sociology; (2) a course in sociological research methods (Sociology 385 or equivalent); (3) fifteen semester hours of undergraduate work in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Students who can not meet the departmental requirements listed above may register for graduate courses but must remove any deficiencies during the first year of residence by taking without credit such courses as may be prescribed by the adviser. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology. Students are admitted on limited status.

Applicants for admission who have taken graduate work in sociology elsewhere are accepted in accordance with the regulations of the Graduate College applicable to such cases. Students applying for admission with advanced standing should thoroughly familiarize themselves with these regulations, which are printed in the general section of this catalog.

Degree of Master of Arts. The requirements for the degree of Master of Arts in Sociology are as follows: (1) Satisfactory completion of a program of eight units of work approved by the adviser. This program must include Sociology 489, 491, some work in sociological theory, and, if prescribed by the adviser, in sociological research methods. (2) Preparation of an acceptable thesis which embodies the results of an original research project. Normally, no more than one unit of credit is allowed for the master's thesis. (3) Passing the master's general

examination. This is a written comprehensive examination of eight hours duration. Preparation for the examination is achieved partly through the work required in Sociology 489, which consists of supervised readings in sociological theory, social psychology, research methods, and general anthropology.

Degree of Doctor of Philosophy. The doctoral program of the department is governed according to the applicable regulations of the Graduate College and specific requirements prescribed by the department. A student who has earned the master's degree in sociology, or its equivalent, and who desires to continue toward the doctorate is permitted to do so unless the graduate faculty of the department deems it inadvisable. The student who is granted permission to continue should consult with his adviser for assistance in the selection of a program of study, which must include an adequate amount of work in sociological theory, scientific method in sociology, and research techniques. The program should be arranged partly with a view toward gaining preparation for the preliminary examination. However, formal course work alone does not provide adequate preparation for the examination. It must be supplemented by an intensive program of individual study and reading selected under the guidance of the adviser.

Candidates for admission to the preliminary examination must be prepared to be examined in five sub-fields of sociology and in the minor subject or subjects. The fields of sociology covered by the examination are: (1) history of sociology and general systematic sociology; (2) individual and the group and collective behavior; (3) community analysis, ecology, and demography; (4) social organization, disorganization, and social process; and (5) sociological methodology and research methods. Information regarding the specific topics included in these fields may be obtained from the adviser.

Upon the recommendation of his adviser, and after he has complied with the relevant regulations of the Graduate College, the student may apply in writing to the executive committee of the department for admission to the preliminary examination, which is given at irregular intervals determined by the needs of the department. The examination consists of a written examination of twenty to twenty-five hours distributed over five days, and a two-hour oral examination. In accordance with the regulations of the Graduate College, the student must be prepared to announce the tentative topic of his proposed doctoral dissertation at the time of the oral portion of the preliminary examination. He should also be prepared to answer questions regarding the topic and the plan for the research.

FELLOWSHIPS AND ASSISTANTSHIPS

The University offers valuable fellowships for graduate study in all fields including sociology and anthropology. Information concerning the stipend currently paid and application forms may be obtained by writing to the office of the Graduate College.

The department offers teaching and research assistantships to qualified applicants. Information and application forms may be obtained from the chairman of the department, 320 Lincoln Hall.

Teaching assistantships with stipends of $1,500 plus exemption from tuition fees for half-time service during the academic year normally are awarded only to applicants who have completed at least one year of graduate work. Applications for appointment as alternates are accepted from others who although having less than one year of graduate work are otherwise exceptionally well qualified by reason of maturity, training, and experience. Applications should be submitted by March 1, but later applications are considered.

Research assistantships in limited numbers are usually available, depending upon the current progress of individual and departmental research projects. Appointments are usually made at the beginning of the academic year but some may be made at any time during the year when vacancies occur. Applicants

for research assistantships must possess superior qualifications of training or experience in quantitative and other methods of research which fit the needs of the particular project.

Specialized assistantships and fellowships other than those mentioned above may be available from time to time. Information regarding those currently available may be obtained from the chairman of the department.

GRADUATE TEACHING FACULTY

Professors: J. W. Albig, W. W. Bauder, O. Lewis, D. E. Lindstrom, J. C. McGregor, J. H. Steward.

Associate Professors: J. E. Hulett, Jr. (Chairman of Department), E. A. Ahrens, Margaret K. Chandler, R. Dewey, C. L. Folse, A. W. Gouldner, E. H. Shideler, B. F. Timmons.

Assistant Professors: R. W. England, D. Glaser, J. R. Gusfield, R. W. Janes, M. Kaplan, B. Karsh, E. H. Winter, D. E. Wray.

COURSES FOR GRADUATES

400. **General Sociology.** Systematic sociology, with emphasis on the development and problems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. I; 1 unit. Gouldner.

407. **Topical Seminar in Rural Sociology.** Same as Rural Sociology 407. Analysis of topics of special interest such as population, migration, rural cultural change, rural culture and personality development, rural regions, and comparative rural societies. I; 1 unit. Prerequisite: Six hours of sociology and a course in introductory statistics. Staff.

412. **Seminar in Social and Cultural Relations of Personality.** Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. I, II; 1 unit. Hulett.

414. **Social Situation and the Social Act.** An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. I or II; 1 unit. Prerequisite: One unit of graduate credit in sociology. Hulett.

418. **Seminar in Industrial Sociology.** Same as Labor and Industrial Relations 418. Individual research in sociological interpretation of industrial organization; the orientation and motivation of the individual in industry and commerce; labor-management relations as group adjustments; the interrelations of industry and the community. I; 1 unit. Prerequisite: Six hours of sociology including Sociology 318, or consent of instructor. Wray.

420. **Seminar in Education for Marriage and the Family.** Review of pertinent recent literature including critical analysis of college and secondary school texts; individually assigned research projects. Emphasis is on teacher-leader preparation. I or II; 1 unit. Prerequisite: Sociology 220 recommended. Timmons.

422. **Theory of Social Groups.** A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations

relevant to the solution of empirical problems in group analysis. I or II; 1 unit. GLASER.

423. **The Primary Group.** An intensive analysis of primary groups in terms of types, their structural and functional characteristics, their relationships to other units of social structure, and their role in the socialization processes. Semi-independent research projects are included as part of the course work. I or II; 1 unit. Prerequisite: Sociology 422 or consent of instructor.

424. **Seminar in Penology.** Sociological analysis of law enforcement, adjudication, and the rehabilitation of criminals, with emphasis on direct contact with agencies having these functions, and the design of research projects relevant to their problems. I or II; 1 unit. Prerequisite: Sociology 331 or equivalent. ENGLAND, GLASER.

425. **Racial and Cultural Minorities.** A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. I or II; 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology. GLASER.

430. **Seminar in Social Effects of Poverty, Their Prevention and Treatment.** Critical examination of classical and popular theories of causes and treatment of poverty, with emphasis on recent studies and programs of prevention and treatment. I or II; 1 unit. Prerequisite: Sociology 230 and undergraduate economics are recommended. TIMMONS.

431. **Seminar in Criminology.** Analysis of selected research problems on the development of criminological thought and the investigation of the causes of crime. I or II; 1 unit. Prerequisite: Sociology 331 or equivalent. ENGLAND, GLASER.

432. **Critique of Research in Juvenile Delinquency.** Analysis of major investigations into the causes, treatment, and prevention of delinquency and criminality in youth. I or II; 1 unit. Prerequisite: Sociology 331 or consent of instructor; Sociology 431 is recommended. ENGLAND, GLASER.

435. **Field Instruction and Research in Penal Sociology.** Problems of designing and conducting criminological research in penal institutions; supervised training and practice in the functions of sociologists in prisons. Conducted only in the summer with the first and eighth weeks spent on campus; six weeks are spent in the offices of sociologists in prisons. Application for admission to this course must be made in April prior to the summer session in which enrollment is desired. S; 1 unit. Prerequisite: Sociology 324 and 331 or equivalent; consent of instructor; passing routine employment clearance procedures (including fingerprinting) required by the prison. ENGLAND, GLASER.

444. **Seminar in Public Opinion.** Same as Mass Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. I, II; 1 unit. ALBIG.

446. **Opinion Polling Analysis.** Same as Mass Communications 446. The study of current polling practices, organizations, and findings. Evaluation of results in terms of the prediction and interpretation of social behavior. I, II; 1 unit.

447. **Sociology of International Conflict.** I or II; 1 unit.

471. **Regionalism and Social Morphology.** Specific analysis of the problems which apply to regional bases and not to the conventional political boundaries. I or II; 1 unit.

473. **The Community in Modern American Society.** Comparative analysis of community life as it is influenced by institutional trends of the larger society. I or II; 1 unit. Prerequisite: Sociology 400. JANES.

76. **Urban Communities and Urbanization.** Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. I or II; 1 unit. DEWEY.

77. **Rural Communities.** Same as Rural Sociology 477. A study of rural community structure, functions, and processes, to give the student a concrete picture of how rural communities operate, and the forces which cause change in the group life of the people living in a rural community. Field trip; estimated expense, $5. II; 1 unit. LINDSTROM.

80. **Sociological Theory and Method.** This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. I or II; 1 unit. GOULDNER.

81. **Seminar in Culture Integration.** I or II; 1 unit. LEWIS.

82. **Recent Developments in Sociology.** Intensive study of selected topics based on contemporary works of major importance in the development of sociological theory. II; 1 unit. Students may reregister for a total of two units credit. ALBIG.

85. **Sociological Prediction Methods.** An analysis of the research principles and problems involved in predicting social behavior, with special illustrations from the prediction of criminality and of adjustment to correctional supervision, from predicting marital adjustment, and from other prediction research. I or II; 1 unit. Prerequisite: Sociology 385 or equivalent. GLASER.

87. **Special Problems in Rural Sociology.** Same as Rural Sociology 487. I, II; ½ to 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

88. **European Sociological Theory.** Selected problems of contemporary sociological thought, e.g., the question of objectivity (sociology of knowledge); what constitutes sociology as a special science; the problem of social dynamics. I or II; 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. AHRENS.

89. **Readings in Sociology.** A list of readings required of all first-year graduate students. The student must pass an examination based on these readings as one of the departmental requirements for the degree of Master of Arts. I, II; 1 unit. HULETT.

90. **Individual Topics in Sociology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. I, II; ½ to 2 units.

91. **Thesis (Master's).** Preparation of theses. I, II; ½ to 1 unit. STAFF.

92. **Thesis (Doctoral).** Preparation of theses. I, II; ½ to 4 units. STAFF.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

15. **Sociology of Education.** Same as Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. I, II; ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. SHIDELER.

17. **Structure and Function of Rural Society in America.** A functional analysis of the group, institutional, and class structure of contemporary American rural society, with emphasis on regional and subregional variations and the interdependence of the rural and other segments of the total American society. I; ½ unit. Offered in 1957-1958 and in alternate years. Prerequi-

site: Three hours of sociology, eight hours of social science, or consent o instructor. FOLSE.

318. **Human Relations in Industry.** Same as Labor and Industrial Relations 318 Sociology of industry and problems of personal adjustment; the emergenc of modern industrial and labor organizations and their impact upon com munity life. I, II; ½ unit. Prerequisite: Psychology 100; Sociology 10 or 104 and 105, or Division of General Studies 151 and 152, or consent o instructor. KARSH.

320. **Social Roles.** Contemporary role theory and related concepts such as soci status and social interaction; age-sex, vocational, social class, and other rol types; applications of this theory to the study of the socialization process an personal adjustment, and the analysis of critical group situations and soci change. I or II; ½ unit. Prerequisite: Sociology 100, or 104 and 105, o Division of General Studies 151 and 152. HULETT.

323. **The Small Social Group.** Theory, observation, and analysis of face-to-fac social groups, such as friendships, cliques, clubs, committees, and labora tory and experimental groups. Deals with the characteristics, functions, an forms of interaction of small groups and covers recent theoretical and em pirical developments in this field of sociology. I, II; ½ unit. Prerequisite Sociology 100 or Rural Sociology 117. SHIDELER.

324. **Penology.** Probation; parole; methods of institutional treatment. I or II ½ unit. Prerequisite: Sociology 331. ENGLAND.

331. **Criminology.** Nature and extent of crime; past and present theories of crim causation; criminal behavior in American society and its relation to persona and cultural conditions. I, II; ½ unit. Prerequisite: Sociology 100, or 10 and 105, or Division of General Studies 151 and 152. ENGLAND, GLASER.

332. **Prevention and Treatment of Juvenile Delinquency.** Conceptions of delin quency and its causation; the juvenile court movement; juvenile detention treatment of juvenile offenders; delinquency prevention programs. I or II ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of Genera Studies 151 and 152, or Sociology 331. ENGLAND, GLASER.

340. **Social Movements.** Analysis of the factors in the formation and dynamics o social movements as collective behavior; patterns of growth, types of lead ers, control mechanisms. I, II; ½ unit. Prerequisite: Sociology 100, or 10 and 105. SHIDELER.

344. **Public Opinion.** Opinion changes and control; propaganda; interest group and opinion; critical review of methods of measurement. I, II; ½ unit. Pre requisite: Sociology 100, or 104 and 105, or Division of General Studie 151 and 152. ALBIG.

347. **Sociology of International Conflict.** War as a social process; conflict o national cultures; population pressures; race relations, immigration policies restrictions on communication, and other elements in the international con flict process; occupation policies in Germany and Japan; implications o social science for changes in the process. II; ½ unit.

372. **Contemporary International Migration.** Demographic, cultural, ideological and other factors in present-day movements of peoples; controlled and com pulsory migration; immigrant groups and displaced persons in the Unite States; national and international migration policies. I or II; ½ unit. Pre requisite: Three hours of sociology or eight hours of social science.

375. **Sociology of the Community.** Nature, structure, and functions of the com munity; types of communities and examples of some better community studies the relation of the community to the larger social organization. I or II; ½

unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or eleven hours of sociology. TIMMONS.

378. **Acculturation in Modern Society.** Acculturation as a universal social process. Deals with the influence of contacts between cultures as a factor in social-cultural change. Emphasis is placed on changes in ideology, technology, and personality types as a consequence of contacts between Western, Oriental, and other civilizations. I, II; ½ unit. Prerequisite: Five hours of sociology. JANES.

385. **Methods of Sociological Research.** The application of principles of research and sampling design to sociological problems; procedures for collection and analysis of data, including the fundamentals of quantitative methods; discussion and criticism of examples of current sociological research. I, II; ½ unit. Prerequisite: Eight hours of sociology. CHANDLER.

386. **Methods of Field Research.** Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. I, II; ½ or 1 unit. Prerequisite: Three hours in advanced courses in sociology or consent of instructor. KARSH.

Anthropology

A student intending to elect anthropology as his major must fulfill the general requirements of the Graduate College. He must also have a general background of preparation in anthropology such as would be provided by an undergraduate major or its equivalent. A student lacking such preparation may be permitted to register for graduate work but he is required to make up his deficiencies to the extent prescribed by his adviser by taking specified undergraduate courses without credit. Students are admitted on limited status.

A student intending to offer anthropology as a minor in connection with a major in some other field must have had at least six hours of undergraduate work in anthropology and should consult with the chairman of the department before registering for courses.

Degree of Master of Arts. The requirements for the degree of Master of Arts in Anthropology are (1) satisfactory completion of an approved program of eight units of work, (2) preparation of an acceptable thesis which embodies the results of an original research project approved in advance by the student's committee, and (3) passing a written comprehensive examination designed to test the candidate's knowledge of anthropology in its broader factual and theoretical aspects.

The candidate's program of work is supervised by a committee appointed by the chairman of the department, consisting of the adviser and one additional member of the anthropology graduate faculty.

COURSES FOR GRADUATES

450. **Seminar in Anthropology.** Analysis of selected topics of special interest in anthropology. I or II; 1 unit. Students may reregister in this course up to a total of two units. WINTER.

460. **Theories and Methods in Anthropology.** A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. I or II; 1 unit. MCGREGOR.

461. **The Cultural Approach in Anthropology.** Seminar on the historical, comparative, and holistic methods of anthropology. I or II; 1 unit. Prerequisite: Consent of instructor. STEWARD.

462. **Cultural Method and Contemporary Native Populations.** Seminar on the use of anthropological methods in the analysis of native populations, with special reference to studies of communities, classes, castes, and other subcultural groups. I or II; 1 unit. Prerequisite: Anthropology 461 or consent of instructor. STEWARD.

489. **Readings in Anthropology.** Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interests of the student. I, II; ½ to 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser.

490. **Individual Topics in Anthropology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. I, II; ½ to 2 units. Prerequisite: Consent of instructor.

491. **Thesis (Master's).** Preparation of theses. I, II; ½ to 2 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

353. **Southwestern Archaeology.** Detailed study of one archaeological unit in the United States. Covers the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. MCGREGOR.

354. **Field Techniques in Archaeology.** An intensive six-week course in the field techniques and methods employed in American archaeology, covering all phases of such training from setting up a field camp, through excavation, recording, cataloguing, and preliminary field study to partial evaluation. S; ½ or 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. MCGREGOR.

355. **Laboratory Techniques and Problems in Archaeology.** Training in the laboratory methods and techniques of dealing with archaeological problems. A specific problem is assigned to each student for solution. S; ½ or 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. MCGREGOR.

356. **Physical Anthropology.** The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or, with consent of instructor, a course in anatomy or comparative anatomy, or physiology, or introductory zoology. MCGREGOR.

361. **Ethnology of Middle America.** A survey of the peoples and cultures of Middle America with special emphasis upon Mexico and Guatemala. Begins by placing Middle America geographically, historically, and culturally within the broader Latin-American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. LEWIS.

362. **Patterns of Folk and Peasant Cultures.** An analysis of the development of folk and peasant cultures in various parts of the world. Data are drawn from

archaeological and historical records as well as from contemporary ethnological studies. II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

363. **Religion in Primitive Society.** An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. II; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Anthropology 102 and 103, or consent of instructor. LEWIS.

364. **Field Work in Cultural Anthropology.** Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; ½ or 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. LEWIS.

365. **Analysis of Field Data in Cultural Anthropology.** Evaluation, organization, and write-up of field data. S; ½ or 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; consent of instructor. LEWIS.

366. **Peoples of Southeast Asia and Indonesia.** Survey of native cultures, economic bases, social and political structure, religion, arts, culture history, and racial types. Deals in general with several of the following areas: the Indo-Chinese Peninsula, Malaya, the Philippines, and the Malay Archipelago. Intensive study of one or two selected ethnic or tribal groups. II; 1 unit. Prerequisite: One course in anthropology or sociology, or consent of instructor. NEEDHAM.

367. **Cultures of Native Africa.** A survey of the native cultures of Africa with particular emphasis on the development of culture types and the patterns of behavior associated with them. I or II; ½ or 1 unit. Prerequisite: Sociology 104 or consent of instructor. WINTER.

368. **Peoples and Cultures of India.** A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. I; ½ or 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: One course in anthropology or sociology, or consent of instructor. LEWIS.

380. **Applied Anthropology.** The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in non-industrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. II; ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

SPANISH AND ITALIAN

(Including Portuguese)

The Department of Spanish and Italian offers courses leading to the degrees of Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese,

and to a Master of Arts in the Teaching of Spanish. Fields of concentration are linguistics, Spanish literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 4.0 for that portion of the work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. However, students are admitted on limited status. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, and consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for an advanced degree in Spanish must acquire a practical command of the language. Some knowledge of Italian or Portuguese is required. A considerable amount of parallel training in one or more other languages or literatures, such as English, French, German, Greek, or Latin, is indispensable. In any case, some Latin is required of candidates for the degree of Doctor of Philosophy. This requirement is usually met by taking a minimum of one semester of Latin, at any level suggested by the student's preparation, while in residence for the doctor's degree. In very special cases, with the consent of the adviser, Spanish literature and linguistics may be used reversibly as major and one minor. More commonly, however, the minor or minors for a major in Spanish literature or linguistics are chosen from some other language and literature, from anthropology, history, philosophy, or other pertinent subjects.

Candidates for an advanced degree or for a minor in Italian or Portuguese should consult the department. Provisions are made to fit individual cases.

Candidates for the degree of Master of Arts in the Teaching of Spanish must earn four units in Spanish, two units in education, and two units in electives. Requirements are Spanish, four units (middle group courses, one to two units, and graduate courses, two to three units); education, two units, including two of the following: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in Spanish and the electives must be selected with the approval of the adviser. The electives may be in Spanish, in Humanities 301, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the department. Students are not admitted to this program on limited status. The adviser for candidates for this degree is Professor Joseph S. Flores, 214 Lincoln Hall.

ASSISTANTSHIPS

A limited number of teaching assistantships are available. Application may be made to the head of the department, 218 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: J. Van Horne (Head of Department), J. H. D. Allen, H. R. Kahane, R. P. Oliver.
Associate Professors: J. S. Flores, Angelina R. Pietrangeli.
Assistant Professor: F. P. Ellison.
Instructors: J. O. Crosby, Francine W. Frank, Harriett Hutter, Louise H. Wester.

Spanish

COURSES FOR GRADUATES

405. Introduction to Critical Method. I; ¼ unit. Oliver.

411. Spanish Literature in the Middle Ages. I; 1 unit. Offered in 1956-1957 and in alternate years. Allen.

412. **Spanish Literature in the Middle Ages.** II; 1 unit. Offered in 1956-1957 and in alternate years. ALLEN.

413. **Contemporary Literature.** Twentieth century writing in Spain and Spanish America. I; 1 unit. VAN HORNE.

414. **Contemporary Literature.** Twentieth century writing in Spain and Spanish America. II; 1 unit. VAN HORNE.

415. **Spanish Literature in the Sixteenth Century.** I; 1 unit. Offered in 1957-1958 and in alternate years. OLIVER.

416. **Spanish Literature in the Sixteenth Century.** II; 1 unit. Offered in 1957-1958 and in alternate years. OLIVER.

417. **Seventeenth Century Literature.** I; 1 unit. Offered in 1956-1957 and in alternate years. FLORES.

418. **Seventeenth Century Literature.** II; 1 unit. Offered in 1956-1957 and in alternate years. FLORES.

419. **Spanish Literature of the Golden Age.** Special problems in the literature of the Golden Age. S; 1 unit. KAHANE.

421. **Modern Spanish and Spanish-American Novel.** I; 1 unit. Offered in 1957-1958 and in alternate years. PIETRANGELI.

422. **Modern Spanish and Spanish-American Novel.** II; 1 unit. Offered in 1957-1958 and in alternate years. PIETRANGELI.

431. **Spanish-American Literature, I: Mexico and Central America.** I; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Spanish 303 and 304, or equivalent. VAN HORNE.

432. **Spanish-American Literature, II: Colombia and the Caribbean.** II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Spanish 303 and 304, or equivalent. VAN HORNE.

433. **Spanish-American Literature, III: The Pacific Coast of South America.** I; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Spanish 303 and 304, or equivalent. VAN HORNE.

434. **Spanish-American Literature, IV: The Río de la Plata Region.** II; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Spanish 303 and 304, or equivalent. VAN HORNE.

441. **Seminar in the Science of Literature.** The application of recent methods of literary science to Spanish literature. S; 1 unit. KAHANE.

451. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. I; 1 unit. Offered in 1956-1957 and in alternate years. KAHANE.

452. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. II; 1 unit. Offered in 1956-1957 and in alternate years. KAHANE.

453. **Old Spanish.** I; 1 unit. Offered in 1957-1958 and in alternate years. KAHANE.

454. **Old Spanish.** II; 1 unit. Offered in 1957-1958 and in alternate years. KAHANE.

491. **Seminar (Thesis Course).** Research in special topics. I, II; 1 to 4 units. ALLEN, KAHANE, OLIVER, VAN HORNE.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

01. **Survey of Spanish Literature.** I; ½ unit. Prerequisite: Spanish 202 or equivalent.

302. **Survey of Spanish Literature.** II; ½ unit. Prerequisite: Spanish 202 o equivalent.

303. **Survey of Spanish-American Literature.** I; ½ unit. Prerequisite: Spanis 202 or equivalent. Ellison.

304. **Survey of Spanish-American Literature.** II; ½ unit. Prerequisite: Spanis 202 or equivalent. Ellison.

311. **Cervantes: Don Quixote.** I; ½ unit. Offered in 1957-1958 and in alternat years. Prerequisite: Spanish 202 or equivalent. Crosby.

312. **Cervantes: Don Quixote.** II; ½ unit. Offered in 1957-1958 and in alternat years. Prerequisite: Spanish 202 or equivalent. Crosby.

313. **Classical Spanish Drama.** I; ½ unit. Offered in 1956-1957 and in alternat years. Prerequisite: Spanish 202 or equivalent. Oliver.

314. **Classical Spanish Drama.** II; ½ unit. Offered in 1956-1957 and in alternat years. Prerequisite: Spanish 202 or equivalent. Oliver.

321. **Modern Spanish and Spanish-American Drama.** I; ½ unit. Prerequisite Spanish 202 or equivalent. Wester.

322. **Modern Spanish and Spanish-American Drama.** II; ½ unit. Prerequisite Spanish 202 or equivalent. Wester.

331. **La Cultura Hispánica: España.** I; ½ unit. Van Horne.

351. **Phonetics.** I, II; ½ unit. Prerequisite: Spanish 202 or equivalent. Flores

352. **Syntax.** I, II; ½ unit. Prerequisite: Spanish 202 or equivalent. Kahane

371. **Spanish for Teachers.** A consideration of language problems suggested b teaching experience. S; ½ unit. Prerequisite: Spanish 104 or equivalent Van Horne.

Italian

COURSES FOR GRADUATES

411. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** I; 1 unit Offered in 1956-1957 and in alternate years. Oliver.

412. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** II; 1 unit Offered in 1956-1957 and in alternate years. Oliver.

415. **Italian Literature of the Renaissance.** I; 1 unit. Offered in 1957-1958 and in alternate years. Oliver.

416. **Italian Literature of the Renaissance.** II; 1 unit. Offered in 1957-1958 and in alternate years. Oliver.

451. **Seminar in Italian Linguistics.** I; 1 unit. Kahane.

452. **Seminar in Italian Linguistics.** II; 1 unit. Kahane.

491. **Seminar (Thesis Course).** Research in special topics. I, II; 1 to 4 units. Kahane, Oliver, Van Horne.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Dante: La Divina Commedia.** I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. Pietrangeli.

312. **Dante: La Divina Commedia.** Continuation of Italian 311. II; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. Pietrangeli.

321. **Modern Italian Literature.** I; ½ unit. Offered in 1957-1958 and in alter-

nate years. Prerequisite: Italian 101 and 102; Italian 103 and 104 are desirable. VAN HORNE.

322. **Modern Italian Literature.** II; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. VAN HORNE.

Portuguese

COURSES FOR GRADUATES

491. **Seminar (Thesis Course).** Research in special topics. I, II; 1 to 4 units. ALLEN, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Brazilian Literature.** Survey of the contemporary Brazilian novel. I; ½ unit. Prerequisite: Portuguese 101 and 102. Portuguese 103 and 104 are desirable. ALLEN.

302. **Introduction to Portuguese Literature.** Survey of the Golden Age of Portuguese. II; ½ unit. Prerequisite: Portuguese 101 and 102. Portuguese 103 and 104 are desirable. ALLEN.

SPEECH

The Department of Speech offers courses leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy.

The admission requirement, in terms of grade-point average, is at least 3.5 for that portion of work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are admitted on limited status except in the special curricula in the teaching of speech and in speech correction.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theater, oral interpretation, speech science, speech and hearing disorders. They may also select a special curriculum in the teaching of speech.

For the degree of Master of Science, students may take a special curriculum in speech correction.

For the degree of Doctor of Philosophy, students may exercise one of three options: rhetoric and public address; the theater; speech science, speech and hearing disorders.

In addition to the general regulations of the Graduate College with respect to entrance, distribution of credits, examinations, and theses, the Department of Speech specifies the requirements listed below.

Degree of Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech. If he does not present sixteen hours of credit in speech, he must make up the deficiency before he can be regarded as a candidate for a graduate degree. His record should include these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theater, and an advanced course in public speaking or discussion.

In consultation with the head of the department, the candidate chooses an adviser with whom he should confer about all details of his program.

A normal program of study requires eight graduate units (four each semester) for graduation. The student with a well-rounded undergraduate educa-

tion may take all eight units in speech; other students are expected to declare a major in speech (to consist of at least four units) and one or two minors in related fields of study outside the department. As a rule, a minor does not exceed two units.

Whether or not a thesis is presented depends upon the candidate's educational and professional aims. After consultation with the student, the student's adviser and the head of the department decide in each case whether a thesis should be submitted as part of the degree requirements. Students who expect to go on to a doctor's degree as a rule are required to present a thesis.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated. The examination covers in part the general field in speech and in part the candidate's area of specialization.

Although no reading knowledge of a foreign language is required for the master's degree, students who expect to do further graduate study should become familiar with the language requirements for the doctor's degree.

Degree of Master of Arts in the Teaching of Speech. Candidates for the Master of Arts degree who are interested in public school teaching should meet the following requirements:

(1) In the area of rhetoric and public address: speech, three units, including Speech 322 and 423, and one and one-half units chosen from 311 and 312; education, two units, including two of the following: Education 301, 302, 303, 304, one unit, and Education 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of the theater: speech, four units, including Speech 361 or 362 or 366, 352, 451, 452; education, two units, including two of the following: Education 301, 302, 303, 304, one unit, and Education 311 and 312, one unit; electives, two units.

Degree of Master of Science in Speech Correction. This program is designed for teachers who have completed a Bachelor of Science in Speech Correction at the University of Illinois or its equivalent at a recognized college or university and who desire to obtain an advanced degree in speech correction.

The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all of the requirements of a four-year undergraduate curriculum but who desire to take the fifth year of work for a master's degree may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 383, 387, 475, 476, 481, 483, 486, 488, 489, 493; two units of education, one unit from Education 301, 302, 303, 304, and one unit from Education 311 and 312; two units of electives. The electives may be in speech, in education, in psychology, or, in exceptional cases, in other fields.

Degree of Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree from an accredited institution. In consultation with the head of the department, the doctoral candidate, like the master's candidate, secures a departmental adviser.

For the student not holding an advanced degree, twenty-four graduate units are required; for the student who holds an advanced degree, sixteen graduate units must be completed. Although the majority of the units are taken within the department, each candidate must choose at least one minor subject outside the department to consist of not less than four units. The candidate may choose two minor subjects, and in that case the second minor consists of not less than two units. If two minors are selected, one must be closely related to the student's area of emphasis. With the approval of the adviser and the Dean of the Graduate College, the second minor may represent a division of the major field of study.

All candidates for the doctor's degree are required to present a thesis which counts for no more than eight graduate units.

At the end of the second year of graduate study, the candidate must pass a preliminary examination. This examination is written; it covers the student's area of specialization and the areas of knowledge represented by the candidate's graduate program. The final examination, after completion of the thesis, is oral and is for the most part restricted to the research represented by the thesis.

A reading knowledge of two foreign languages, German and usually French, is required of all candidates. The examination in both languages must be passed satisfactorily before the preliminary examination may be taken.

FELLOWSHIPS AND ASSISTANTSHIPS

Persons interested in fellowships should seek specific information from the Dean of the Graduate College. Persons interested in assistantships should communicate with the head of the department. Assistantships provide opportunity to combine graduate study and one of three kinds of experience: teaching an elementary course in extemporaneous speaking or in oral interpretation; assisting in theater production; assisting in the speech and hearing clinics.

GRADUATE TEACHING FACULTY

Professors: K. R. Wallace (Head of Department), E. T. Curry, G. Fairbanks, M. T. Herrick, B. Hewitt, R. Murphy, Severina E. Nelson, J. W. Swanson.

Associate Professors: O. A. Dieter, H. E. Gulley, Marie K. Hochmuth, L. S. Hultzén, J. C. Kelly, H. L. Mueller, J. W. Scott, C. H. Shattuck, K. A. Windesheim.

Assistant Professors: Clara M. Behringer, K. Burns, M. T. Cobin, C. L. Hutton, R. E. Nadeau.

Instructor: W. Smalley.

COURSES FOR GRADUATES

403. **Seminar in Problems of Speech Instruction.** Investigation of current philosophies, methods, and materials as they relate to effective instruction in the various areas of speech. I; 1 unit. Burns.

411. **The Greek Tradition in Rhetoric and Oratory.** The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to the Renaissance; analysis of the contributions of major figures and works to that tradition. I; 1 unit. Nadeau.

412. **The Roman Tradition in Rhetoric and Oratory.** Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. II; 1 unit. Dieter.

423. **The Rhetoric of Aristotle.** Study of the *Rhetoric* in relation to other works of Aristotle. I; 1 unit. Wallace.

430. **Contemporary Theories of Oral Communication.** Systematic study of speech-making and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. I or II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Consent of instructor. Gulley.

436. **Seminar in Public Discussion.** Investigation of special problems in public discussion. II; 1 unit. Offered in 1956-1957 and in alternate years. Murphy.

438. **Seminar in Rhetorical Theory.** Study of special topics in the history of rhetorical theory. II; 1 unit. Wallace.

441. **Principles and Theories of Oral Interpretation.** Historical survey of British and American theories of interpretation. I; 1 unit. COBIN.

442. **Seminar in Oral Interpretation.** Investigation of basic problems in the history, nature, and function of oral interpretation. II; 1 unit. Prerequisite: Speech 441; consent of instructor. COBIN.

451. **Problems in Play Directing in the School Theater.** Study of the audience, play selection, the actor's abilities and needs, try-outs and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. I; 1 unit. SWANSON.

452. **Problems in Play Production in the School Theater.** Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. II; 1 unit. SWANSON.

461. **Advanced Theater Techniques.** Individual development of advanced techniques of acting and staging through supervised participation in public productions. S; ½ to 1 unit. Prerequisite: At least one semester of graduate study in the area of theater; consent of head of the department and instructor. BEHRINGER.

463. **Seminar in the History of Acting.** Studies in the history and theory of the art of acting. II; 1 unit (students may accumulate 2 units). Offered in 1957-1958 and in alternate years. SHATTUCK.

465. **Seminar in Theater Art.** Studies in the aesthetics of the theater. I; 1 to 2 units. HEWITT.

468. **Seminar in Theater History.** Studies in the history of the theater. II; 1 to 2 units. HEWITT.

471. **Electroacoustics of Speech.** The application of acoustical and electrical principles to the analysis of speech. Lectures, demonstrations, and laboratory work. I or II; 1 unit. Prerequisite: Speech 375 and 376. CURRY.

472. **Psychoacoustics of Speech.** Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. II; 1 unit. Prerequisite: Consent of instructor. CURRY.

473. **Seminar in Phonetics.** Advanced study in phonetic theory and noninstrumental phonetic investigation. I or II; 1 unit. Prerequisite: Consent of instructor. HULTZÉN.

475. **Experimental Phonetics, I.** Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. I; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

476. **Experimental Phonetics, II.** Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. II; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

477. **Measurement of Speech, I.** Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. I; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. FAIRBANKS.

478. **Measurement of Speech, II.** Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. II; 1

unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. FAIRBANKS.

479. **Seminar in Experimental Phonetics.** Advanced consideration of experimental research in the physiological, acoustical, and psychophysical aspects of speech and hearing. Extensive survey of current literature. S; 1 unit. Prerequisite: Speech 475 and 476, or consent of instructor. FAIRBANKS.

481. **Seminar in Voice and Articulation Disorders.** Advanced study of voice and articulation disorders; survey of research and theory; principles of therapy. I or II; 1 unit. Prerequisite: Consent of instructor. KELLY.

483. **Seminar in Psychology of Speech Disorders.** Same as Psychology 483. Advanced theoretical study of psychological disorders of speech such as stuttering, delayed speech, and hysterical conditions; survey of current theory and research. I or II; 1 unit. Prerequisite: Consent of instructor.

486. **Advanced Clinical Techniques in Speech and Hearing.** Practice of advanced clinical therapy for speech and hearing disorders; semi-independent management of complex difficult cases; participation in examination and analysis. I, II; 1 to 4 units. Prerequisite: Consent of instructor. CURRY, NELSON.

488. **Diagnosis of Speech Disorders.** Study of diagnostic procedures used in analysis of symptoms involved in speech disorders. II; 1 unit. NELSON.

489. **Seminar in Organic Speech Disorders.** Principles and methods of clinical and classroom correction of speech disorders associated with organic dysfunctions. I or II; 1 unit. Prerequisite: Consent of instructor. NELSON.

491. **Seminar in Hearing Disorders.** Principles and methods of clinical and classroom management of all types of hearing disorders. Survey of current literature and research. I or II; 1 unit. Offered in 1956-1957 and in alternate years. Prerequisite: Speech 391.

493. **Research in Special Topics.** I, II; 1 to 4 units. COBIN, CURRY, DIETER, FAIRBANKS, GULLEY, HEWITT, HOCHMUTH, HULTZÉN, KELLY, MURPHY, NELSON, SHATTUCK, SWANSON, WALLACE, WINDESHEIM.

495. **Special Problems.** Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. I, II; 1 to 2 units. Prerequisite: Consent of the head of the department. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Phonetics.** Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. I, II; ½ to 1 unit. HULTZÉN, MUELLER.

311. **British Public Address.** Study of representative British speakers from the sixteenth century to the present. Lectures, reports, and papers. I; ½ to 1 unit. Prerequisite: Speech 117 or 221. MURPHY.

312. **American Public Address.** Study of representative American speeches from the sixteenth century to the present. II; ½ to 1 unit. Prerequisite: Speech 117 or 221. HOCHMUTH.

322. **Modern Rhetorical Theory.** Significant movements in the development of rhetorical theory in England, France, and America from 1700 to 1950. I or II; ½ to 1 unit. HOCHMUTH.

342. **Advanced Oral Interpretation.** Oral interpretation of poetry. I, II; ½ to 1 unit. Prerequisite: Speech 141. COBIN.

352. **Theories of Play Production.** Origin and development of modern theatrical production; a critical examination of contemporary ideas and practices in theater architecture, acting, directing, and staging. I; ½ to 1 unit. SWANSON.

353. **Creative Dramatics for Children.** A study of the subject matter and techniques of creative dramatics for children, with laboratory application. S; ½ to 1 unit. Prerequisite: Consent of instructor.

354. **Theater for the Child Audience.** A study of the history, the objectives, and the techniques of play production for the child audience, with laboratory application. S; ½ to 1 unit. Prerequisite: Consent of instructor.

355. **Advanced Play Directing.** A study of advanced directing techniques; styles of drama; specialized procedures. I or II; ½ to 1 unit. Prerequisite: Speech 255 or equivalent. SWANSON.

361. **History of the European Theater to the Renaissance.** The theater and the theater arts of ancient and of medieval Europe. I; ½ to 1 unit. SCOTT.

362. **History of the European Theater from the Renaissance to 1900.** The European theater and the theater arts from 1576 to 1900, with special reference to the English theater. II; ½ to 1 unit. SCOTT.

363. **Advanced Playwriting.** Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing the full-length play. I, II; ½ to 1 unit (students may accumulate 2 units). Prerequisite: Speech 263; consent of instructor. SMALLEY.

366. **Development of the American Theater.** The development of the theater and theater arts in America from colonial times to the beginning of the twentieth century. I or II; ½ to 1 unit. HEWITT.

368. **History of Theater Costume.** A survey of the history of costumes worn on the stage from the classical Greek period to the present. II; ½ to 1 unit. RICHARDSON.

370. **Stage Scenery Design.** Theory and practice of designing stage scenery. II; ½ to 1 unit. Prerequisite: Speech 157 and two of the following: Speech 255, 352, 361, 362; or consent of instructor. SCOTT.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as English 371. I; ½ to 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as English 372. II; ½ to 1 unit. HERRICK.

373. **Phonetics and Phonemics.** Methodologies of phonetics, with special application to English; general principles of phonemic interpretation. I or II; ½ to 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Speech 301. HULTZÉN.

375. **Speech Science.** Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. I, II; ½ unit. Prerequisite: Speech 301 or consent of instructor. CURRY.

376. **Speech Science.** Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. II; ½ unit. Prerequisite: Speech 375 or consent of instructor. CURRY.

383. **Psychological Disorders of Speech.** Principles and methods of clinical and classroom correction of psychological disorders of speech, with special reference to stuttering and delayed speech; clinical and classroom practice with children and adults. I or II; 1 unit. Prerequisite: Consent of instructor.

385. **Speech Correction.** Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation and practice in clinical techniques are provided in the laboratory. I; ½ unit. Prerequisite: Ten hours of speech or consent of instructor. NELSON.

386. **Practicum in Speech Diagnosis and Therapy.** Observation, practice, and research in diagnosis and therapy of speech disorders. I, II; ½ unit. Prerequisite: Speech 385. NELSON.

387. **Voice and Articulation Disorders.** Principles and methods of clinical and classroom correction of voice and articulation disorders. I or II; ½ unit. Prerequisite: Speech 385; consent of instructor. KELLY.

388. **Speech Correction.** Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and glandular disorders. II; ½ unit. Prerequisite: Speech 385. NELSON.

391. **Introduction to Hearing Disorders.** Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. I or II; ½ unit. Prerequisite: Ten hours of speech including Speech 301; consent of instructor. CURRY.

393. **Aural Rehabilitation.** Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling; clinical and classroom practice with children and adults. I, II; ½ unit. Prerequisite: Speech 391; consent of instructor. Required in the curriculum of teacher training in speech correction. HUTTON.

395. **Audiometry and the Use of Hearing Aids.** Selective and diagnostic tests of hearing, the planning and conduct of hearing conservation programs, general problems involved in the use of hearing aids. I, II; ½ unit. Prerequisite: Speech 376. CURRY, HUTTON.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

Graduate students electing theoretical and applied mechanics as their major must have had the equivalent of the undergraduate courses in mechanics required for a bachelor's degree in any of the curricula in the College of Engineering. Admission to graduate study in this department requires a 3.5 grade-point average for that portion of the work which represents the last 50 per cent of the hours completed to secure the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status. Candidates for the Doctor of Philosophy degree are required to take, in addition to the thesis, at least one-half unit from each of the following three groups: (1) Theoretical and Applied Mechanics 321, 323, 326, 421, 422, 424, 427, 451, 452, 461, 462, 464; (2) Theoretical and Applied Mechanics 311, 412, 416; (3) Theoretical and Applied Mechanics 334, 346, 431, 432. Students are advised to take courses in advanced calculus (Mathematics 343) in preparation for some advanced courses in theoretical and applied mechanics.

The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science degree is one unit; for the Doctor of Philosophy degree, the requirement for a first minor is four units and for a second minor, two units.

In the program for graduate study, emphasis is placed on both course work and research, the latter being either analytical or experimental. The department, as part of the Engineering Experiment Station, conducts many research investigations and makes studies of importance to the engineering, manufacturing, and other industrial interests as well as to various governmental agencies. Some of the fields of greatest research activity are properties of materials and the elastic

and inelastic behavior of load-resisting members; fatigue of metals; properties and behavior of plain concrete, reinforced concrete beams, columns, footings, slabs, and frames; creep of lead and of plastics and other inelastic behavior of materials; hydraulics and fluid mechanics; stresses in railway car wheels, rails and bolted and welded rail joints; mechanical vibrations of machines and structures and vibration damping; photoelastic, electric strain gage, and other methods of experimental stress analysis; materials subjected to static and dynamic loads; theoretical analyses of problems in fluid flow, dynamics, theory of elasticity, and theory of plasticity. Controlled environment facilities are available for investigations of plastics and plain and reinforced concrete.

For information concerning applied mathematics, see page 28.

ASSISTANTSHIPS

Part-time assistantships in teaching and research are available. The general qualification is a high scholastic record. Applications for teaching or research assistantships should be addressed to the head of the department, 212 Talbot Laboratory.

GRADUATE TEACHING FACULTY

Professors: T. J. Dolan (Head of Department), W. L. Collins, A. M. Freudenthal (Research Consultant), P. G. Jones, H. L. Langhaar, W. M. Lansford, J. M. Robertson, H. J. Schrader, J. O. Smith.

Associate Professors: C. E. Bowman, C. E. Kesler, O. M. Sidebottom, M. C. Steele, I. M. Viest.

Assistant Professor: M. Stippes.

COURSES FOR GRADUATES

412. Vibration Analysis. Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's method; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; non-linear systems. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 311. Jones.

416. Energy Principles in Engineering Mechanics. Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation, and applications of the principle of virtual displacements, the principle of minimium potential energy, the principle of complementary energy, Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion constitute the main part of the course. Variational methods of approximation are treated briefly. The material includes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. II; 1 unit. Langhaar.

421. Mechanics of Materials. Methods of obtaining relations between loads and stresses and strains in various members. The main topics covered in this course and in Theoretical and Applied Mechanics 422 are curved beams, unsymmetrical bending, thick-walled cylinders, beams on elastic supports, contact stresses, torsion of members with non-circular cross-section, stress concentrations, elastic energy methods applied to statically indeterminate members,

flat plates, inelastic behavior of various types of members. Introduction to mathematical theory of elasticity; elastic and plastic buckling; criteria of failure by yielding and by fracture. I; ½ to 1 unit. SIDEBOTTOM, SMITH.

422. **Mechanics of Materials.** Continuation of Theoretical and Applied Mechanics 421. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 421. SIDEBOTTOM, SMITH.

424. **Properties of Engineering Materials.** Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. II; ½ to 1 unit. COLLINS.

427. **Theories of Mechanical Properties and Behavior of Plain Concrete.** Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial are emphasized. The studies involve critical reviews of experimental and analytical investigations. I; ½ to 1 unit. KESLER.

431. **Theory of Ideal Fluid Flow.** Together with the following course, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible viscosity. The differential equations of motion are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. I; 1 unit. Prerequisite: An elementary course in fluid flow and a course in advanced calculus or equivalent. ROBERTSON.

432. **Theory of Flow of Viscous Fluids.** Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially. Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. II; 1 unit. Prerequisite: An elementary course in fluid flow and a course in differential equations or in advanced calculus. ROBERTSON.

451. **Theory of Elasticity with Application to Engineering Problems.** A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. I; 1 unit. LANGHAAR, STIPPES.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. LANGHAAR, STIPPES.

461. **Inelastic Behavior of Engineering Materials (Theory of Plasticity).** An outline of a general theory of inelastic behavior involving the relations between loads and stresses and strains in various members that are stressed beyond the elastic range. The cases considered include those in which the inelastic actions involve bodies which are made of materials that behave ideally viscous, ideally plastic, and combinations of the two. Some specific topics are mechanisms of inelastic action of members in which the stresses and strains are essentially uni-axial, such as straight beams, curved beams, and members subjected to combined axial and bending loads; deflection of beams; statically indeterminate members loaded inelastically; inelastic buckling; "shake down" of simple statically indeterminate members; etc. I; ½ to 1 unit. SMITH.

462. **Inelastic Behavior of Engineering Materials (Theory of Plasticity).** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading functions. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. SMITH, STEELE.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. II; ½ to 1 unit. LANGHAAR.

491. **Thesis (Master's).** I, II; ½ to 2½ units. STAFF.

492. **Thesis (Doctor's).** I, II; 1 to 4 units. STAFF.

493. **Advanced Independent Study (Special Problems).** Individual investigation of studies, either analytical or experimental, in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Mechanical Vibrations.** Kinematics of vibratory motion; comprehensive study of vibrating systems having a single degree of freedom. Specific topics are natural frequencies in undamped vibration and the energy (Rayleigh) method; viscous, Coulomb, and solid (hysteresis) damping; forced vibration; work done by harmonic forces; method of complex algebra; critical speeds and balancing; balancing machines; vibration isolation; vibration instruments. For systems with several degrees of freedom, specific topics are modes; coupled vibrations; vibration absorbers and dampers; vehicle suspension; Holzer's analysis for torsional systems. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 154 or 156, or 211 and 221. JONES.

321. **Advanced Mechanics of Materials.** Methods used in elementary mechanics of materials are expanded and generalized and used to solve more complex problems. Thick-walled cylinders, torsion of bar having non-circular cross-section; curved beams, unsymmetrical bending, flat plates; theories of failure. Use of energy methods for determining deflections and for solving statically indeterminate problems. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. SIDEBOTTOM, SMITH.

323. **Advanced Laboratory in Materials Testing.** Calibration of testing machines and of strain measuring instruments. Use of various mechanical and electrical strain gages; determination of the mechanical properties of five different materials under various types of tests: tension, compression, torsion, flexure, impact, and hardness; interpretation of test results. Relation of tests to specifications of materials. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. Collins, Wetenkamp.

326. **Experimental Stress Analysis.** Measurement of strains or deformations that are of significance in the engineering design of load resisting members. Systematic applications of optical, electrical, and physical properties of matter to the instrumentation and measurement of model or prototype stresses. The methods studied include models, analogies, brittle coatings, electrical resistance gages, photoelasticity, etc. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 221, and 223. Theoretical and Applied Mechanics 321 is desirable. Bowman.

334. **Fluid Mechanics and Advanced Hydraulics.** A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. Lansford.

346. **Dimensional Analysis and Theory of Models.** The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. II; ½ to 1 unit. Langhaar.

VETERINARY PATHOLOGY AND HYGIENE

Graduate students who choose veterinary pathology and hygiene as a major nust be graduates of a recognized veterinary college. Students applying for ıdmission must have a grade-point average of at least 3.5 for that portion of the vork which represents the last 50 per cent of the hours completed to secure the ›achelor's degree, exclusive of required physical education and military training. n certain cases, students are admitted on limited status. Students whose major s in a related field may register for a minor in veterinary pathology and hygiene.

The Master of Science and Doctor of Philosophy degrees are offered in eterinary pathology and hygiene. Candidates for the master's degree must pass reading knowledge examination in one foreign language in addition to satisfyng the other requirements of the Graduate College for this degree.

ASSISTANTSHIPS

Teaching and research assistantships are available for selected graduate stulents. Applications for assistantships should be directed to the Dean of the College of Veterinary Medicine, 131 Veterinary Medicine Building.

GRADUATE TEACHING FACULTY

Professors: J. O. Alberts (Head of Department), P. D. Beamer, L. E. Boley, H. S. Bryan, N. D. Levine, R. P. Link, L. E. St. Clair, J. Sampson.

Associate Professor: E. F. Reber.

COURSES FOR GRADUATES

401. **Laboratory Diagnostic Methods in Veterinary Bacteriology.** Diagnosis o the animal diseases caused by bacteria, viruses, and fungi. I; 1 unit. Pre requisite: Bacteriology 326 or equivalent. ALBERTS.

402. **Advanced Veterinary Parasitology.** Diagnosis, cultivation, chemotherapy and host-parasite relations of protozoan, helminth, arthropod, and funga parasites of domestic animals. II; ½ to 1 unit. Prerequisite: Veterinar Pathology and Hygiene 324 or Zoology 318 and 321 or equivalent; Chemistr 133 or equivalent. LEVINE.

404. **Seminar.** Required of all graduate students whose major is veterinary path ology and hygiene. I, II; ¼ unit. LEVINE.

405. **Advanced Veterinary Pathology.** Advanced study of gross and microscopi pathology of diseases of domestic animals. I; 1 unit. BEAMER.

406. **The Experimental Method in Veterinary Research.** Planning of experiments use of controls, interpretation of results, sources of error, and writing th research report. Lectures and discussion. I; ¼ unit. LEVINE.

493. **Research and Thesis.** I, II; ½ to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

324. **Parasitology.** Protozoa, helminths, arthropods, and other parasites affectin domestic animals. Lectures and discussions. I; 1 unit. Prerequisite: Consen of instructor. LEVINE.

325. **General Pathology.** The basic principles of pathological processes, includin tissue injury and repair, circulatory and metabolic disturbances, inflamma tion and neoplasms. Lectures, quizzes, demonstrations, and laboratory. II 1 unit. Prerequisite: Consent of instructor. BEAMER.

327. **Parasitology.** Protozoa, helminths, arthropods, and other parasites affectin domestic animals. Laboratory. I; ½ unit. Prerequisite: Credit or registra tion in Veterinary Pathology and Hygiene 324; consent of instructor. LEVINE

332. **Principles of Sanitation in the Processing and Handling of Foods.** Same a Food Technology 332. A study of the principles of sanitation with appropri ate emphasis on practical considerations as they apply to various food proc essing industries. Control of insects, rodents, and microorganisms; funda mentals of detergency; sanitation of water supplies; waste disposal methods Government and public health regulations. Local field trips to food proc essing plants. II; ½ unit. Prerequisite: Bacteriology 104 and Chemistr 132, or equivalent. ORDAL.

ZOOLOGY

The Department of Zoology offers work leading to the degrees of Master o Science and Doctor of Philosophy.

Graduate students who choose zoology as a major must have had at least two years of undergraduate work in zoology. However, under special circumstances, advanced courses in closely allied subjects may be accepted in place of the fourth semester of zoology. Students applying for admission must have a 3.75 grade-point average for that portion of the work which represents the last 50 per cent of the hours earned toward the bachelor's degree, exclusive of required physical education and military training. Students are not admitted on limited status.

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology. Requirements for a minor in zoology are as follows:

Sole Minor: Four units in zoology, at least one of which must be in work ›pen to graduate students only.

First Minor: Three units in zoology, at least one of which must be in work ›pen to graduate students only.

Second Minor: Any two units in zoology offering graduate credit. Students rom other departments must have had a strong undergraduate background in :oology.

A reading knowledge of German and French is indispensable for graduate tudy in zoology, and familiarity with Latin and Greek is of great advantage.

Graduate students whose major is zoology are strongly advised to study at east one summer at a marine biological station. Every candidate for the Doctor ›f Philosophy degree in zoology must furnish evidence of having completed atisfactorily at least six weeks of work at an approved station before being llowed to take the preliminary examination for the doctorate.

Although no special degree in wildlife management is offered, students nay prepare themselves for that type of work by selecting courses from the ollowing list: Zoology 304, 318, 321, 335, 336, 337, 338, 343, 345, 418, 445, 46, and research courses. Such students should choose their minors from botany, hysiology, entomology, and bacteriology.

For the degree of Master of Science in the Biological Sciences or in the eaching of the Biological Sciences and General Science, see page 64.

Special information relating to departmental standards and requirements nd chief fields of specialization within the department may be obtained by riting to the head of the department, 345 Natural History Building.

SSISTANTSHIPS

A limited number of one-fourth and one-half time graduate teaching as-istantships are available in the department. Inquiries concerning such appoint-ients should be directed to the head of the department, 345 Natural History uilding.

RADUATE TEACHING FACULTY

Professors: F. B. Adamstone (Head of Department), B. V. Hall, L. Ingle, S. C. Kendeigh, W. M. Luce, S. M. Rose, L. J. Thomas.
Associate Professors: D. F. Hoffmeister, O. E. Kugler, M. R. Matteson, H. H. Shoemaker, H. M. Smith.
Assistant Professors: J. O. Corliss, J. B. Kitzmiller, F. J. Kruidenier.

OURSES FOR GRADUATES

03. **Cytology.** Structure and organization of the animal cell. I; 1 unit. Prerequisite: Consent of instructor. Adamstone.

04. **Experimental Cytology.** An experimental approach to knowledge of the chemical and physical structure of cells. II; 1 unit. Prerequisite: Zoology 403; consent of instructor.

09. **History of Zoology.** The development of zoological concepts from the classical Greek period to the present. I; ½ to 1 unit. Rose.

1. **Discussions in Genetics and Cytogenetics.** Same as Botany 411. I, II; ¼ unit. Kitzmiller, Laughnan, Luce, Rhoades.

8. **Advanced Protozoology.** Selected topics, with lectures, discussions, readings, and reports; laboratory practice in modern techniques, studying free-living and parasitic forms; collecting trips. II; 1 unit. Prerequisite: Zoology 318 or equivalent. Corliss.

422. **Advanced Helminth Parasitology.** Advanced study of modern methods in helminthology. II; 1 unit. Prerequisite: Zoology 321 or equivalent. THOMAS.

424. **Invertebrate Taxonomy.** Individual problems in taxonomy of invertebrates. II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Zoology 304. MATTESON.

432. **Classification, Phylogeny, and Evolution of Vertebrates.** I; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Zoology 132. SMITH.

433. **Embryology.** A study of initial differences in developing systems and interactions leading to more complex differences. I; 1 unit. Prerequisite: Zoology 333. ROSE.

435. **Animal Behavior.** Seminar on modern concepts, problems, and methods with special reference to vertebrates under free-living natural conditions I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Zoology 335, 336, 337, or 338. KENDEIGH.

445. **Advanced Ecology and Wildlife Management.** Seminar on modern techniques, concepts, and problems. I; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Zoology 345 or equivalent. KENDEIGH.

446. **Physiological Ecology.** Physiological adjustments and responses of organism to their environment. II; 1 unit. KENDEIGH.

455. **Advanced Genetics.** The gene in heredity, development, and evolution. I 1 unit. LUCE.

456. **Physiological Genetics.** The nature of the gene and its action in the developmental and physiological processes of the organism. II; 1 unit. LUCE.

462. **Advanced General Physiology.** Same as Physiology 462. Seminar, lectures student reports, discussions. I or II; ½ unit. Prerequisite: Consent of instructor. PROSSER.

467. **Experimental Embryology.** II; 1 unit. Prerequisite: Zoology 433 or equivalent. ROSE.

493. **Individual Research.** I, II; ½ to 4 units.
Work in the following fields is offered for students registered in Zoology 493

Ecology and Taxonomy: Ecology, KENDEIGH; Herpetology, SMITH; Ichthyology, SHOEMAKER; Limnology, MATTESON, Mammalogy, HOFFMEISTER Ornithology, KENDEIGH; Wildlife Management, KENDEIGH, SHOEMAKER.

Vertebrate Anatomy: Histology, ADAMSTONE; Vertebrate Anatomy, HALL SMITH.

Invertebrate Zoology: Helminthology, THOMAS; Invertebrate Zoology and Field Zoology, INGLE, MATTESON; Parasitology, KRUIDENIER, THOMAS; Protozoology, CORLISS.

Experimental Zoology: Chemical Embryology, KUGLER; Cytology, ADAMSTONE; Embryology and Regeneration, ROSE; Endocrinology, HALL; Genetics and Evolution, KITZMILLER, LUCE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Seminar.** For members of the staff and graduate students. Required of all graduate students. I; no credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Hexapoeca (entomology club).

301. **General Seminar.** For members of the staff and graduate students. Required of all graduate students. II; no credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Anim

Ecology Club, Genetics Seminar, Endocrinology Seminar, and Hexapoecia (entomology club).

302. **Individual Topics.** For those who wish to study individual problems. Graduates may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. I; ½ to 1 unit. Prerequisite: Two years of zoology; approval of department. STAFF.

303. **Individual Topics.** For those who wish to study individual problems. Graduates may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. II; ½ to 1 unit. Prerequisite: Two years of zoology; approval of department. STAFF.

304. **Field and Systematic Zoology.** Collection, preservation, and identification of lower vertebrates and land and fresh water invertebrates; habits and life histories of selected forms. I; 1 unit. Prerequisite: One year of zoology, or equivalent. MATTESON.

306. **Biology for Teachers.** Same as Botany 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. Note: In order to make possible out-of-town practice teaching, this course is completed during the first six weeks of the semester. II; ¼ or ½ unit. Prerequisite: Botany 100 and Zoology 104 or 101, or a year course in general biology. FULLER, MATTESON.

318. **Protozoology.** Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. I; 1 unit. Prerequisite: One year of zoology or equivalent. CORLISS.

320. **Invertebrate Zoology.** Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. II; 1 unit. Prerequisite: Zoology 101 or 104. INGLE.

321. **Helminth Parasitology.** Worm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz, demonstrations, and problems. I; 1 unit. Prerequisite: One year of zoology or equivalent. THOMAS.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology: comparative anatomy, evolution and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous systems. Lectures and laboratory. II; 1 unit. Offered in 1957-1958 and in alternate years. Prerequisite: Zoology 333. HALL.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. I, II; 1 unit. Prerequisite: Zoology 132. ADAMSTONE, KRUIDENIER.

334. **Vertebrate Histology.** Study and preparation of tissues of the vertebrate body. II; ½ unit. Prerequisite: Zoology 333 or consent of instructor. ADAMSTONE.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. II; ½ unit. Prerequisite: Zoology 101 or 104. KENDEIGH.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. I; ½ unit. Offered in 1957-1958 and in alternate years. Prerequisite: Zoology 132. HOFFMEISTER.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. I; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Zoology 132. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. II; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Zoology 132. SMITH.

340. **Natural History of the Vertebrates.** Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. II; 1 unit. Prerequisite: One year of biology including Zoology 101 or 104. SHOEMAKER.

341. **Field Ecology.** Study of biotic communities, birds, and fish in the vicinity of Reelfoot Lake, Tennessee, covering six days. Students may enroll in subsequent years for additional credit by specializing in different fields of study. II; ¼ unit. Prerequisite: Registration in either Zoology 335, 340, or 345, or an equivalent course. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. I; ½ unit. Prerequisite: Zoology 101 or 104. SHOEMAKER.

343. **Limnology.** Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. II; ½ unit. Offered in 1956-1957 and in alternate years. Prerequisite: Zoology 101, 104, or Botany 100. MATTESON.

344. **Field Study of the Vertebrates.** Study of fish, amphibia, reptiles, birds, and mammals, with special emphasis on identification and life histories. Field trips. S; 1 unit. Prerequisite: One year of biology.

345. **Animal Ecology.** Dynamics, development, and distribution of biotic communities. I; ½ to 1 unit. Prerequisite: One year of zoology. KENDEIGH.

351. **Genetics.** Principles of heredity. Lectures, readings, and discussions. II; ½ unit. Prerequisite: Zoology 101 or 104, or one semester of any biological science. LUCE.

352. **Genetics.** Laboratory experiments illustrating the principles of heredity, problems, and demonstrations. II; ½ unit. Prerequisite: Credit or registration in Zoology 351. KITZMILLER, LUCE.

361. **Comparative Physiology.** Same as Physiology 361. A comparison of the general physiology of different groups of animals. I; 1 unit. Prerequisite: Three semesters of animal biology; two semesters of chemistry. ANDERSON, PROSSER.

362. **Cellular Physiology.** Same as Physiology 362. A physico-chemical analysis of biological functions common to most living cells. II; 1 unit. Prerequisite: Two semesters each of biology and general physics; three semesters of chemistry. ANDERSON.

363. **Endocrinology.** Same as Physiology 363. The glands of internal secretion with special reference to the vertebrates. I annually; II in 1958-1959 and in alternate years; 1 unit. Prerequisite: One semester of elementary zoology or physiology; Zoology 334 or organic chemistry. HALL.

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GRADUATE COLLEGE

UNIVERSITY OF ILLINOIS BULLETIN

1958
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1958–1959

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Harold Ray Snyder, Ph.D., Professor of Organic Chemistry

Calendar

SUMMER SESSION, 1958

June 16, Monday	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 15.)
June 17, Tuesday	Instruction begins.
June 27, Friday	Applications to take French examination on July 11 will not be accepted in Graduate College Office after this date.
July 3, Thursday	Applications to take German examination on July 18 will not be accepted in Graduate College Office after this date.
July 4, Friday	Independence Day. No classes.
July 11, Friday evening	French examination.
July 18, Friday evening	German examination.
July 21, Monday	Latest date for dropping a course without a grade of E.
Aug. 8, Fri.—Aug. 9, Sat.	Summer session examinations.
August 8, Friday	No names will be added to the August graduation list after this date.
August 11, Monday	Latest date for candidates for the master's degree in August to deposit theses.
September 12, Friday	Latest date for candidates for Ph.D. degree in October to submit theses and abstracts to Graduate College Office for approval of format.
September 26, Friday	Latest date to file application for the master's degree in October.
September 26, Friday	Latest date for candidates for the master's degree in October to deposit theses.
September 27, Saturday	Latest date for finals for Ph.D. degree in October.
October 3, Friday	Latest date for candidates for Ph.D. degree in October to deposit theses and abstracts.

FIRST SEMESTER, 1958-1959

Sept. 10, Wed.—Sept. 13, Sat.	Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register on September 13. There will be no registration on Saturday, September 20.)
September 13, Saturday	Latest date for registration of former students without payment of late registration fee.
September 15, Monday	Instruction begins.
September 26, Friday	Applications to take French examination on October 10 will not be accepted in Graduate College Office after this date.
October 3, Friday	Applications to take German examination on October 17 will not be accepted in Graduate College Office after this date.
October 10, Friday evening	French examination.
October 17, Friday evening	German examination.
October 27, Monday	Latest date for adding a course to program.
November 1, Saturday	Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to "third" year.
November 21, Friday	Applications to take French examination on December 5 will not be accepted in Graduate College Office after this date.
November 26, Wednesday	Applications to take German examination on December 12 will not be accepted in Graduate College Office after this date.
November 26, Wednesday, 1 p.m.	Thanksgiving vacation begins.
December 1, Monday, 1 p.m.	Thanksgiving vacation ends.
December 5, Friday evening	French examination.
December 8, Monday	Latest date for dropping a course without a grade of E.
December 12, Friday evening	German examination.
December 20, Saturday, 1 p.m.	Christmas vacation begins.
January 5, Monday, 8 a.m.	Christmas vacation ends.
January 9, Friday	Latest date for candidates for Ph.D. degree in February to submit theses and abstracts to Graduate College Office for approval of format.
January 15, Thursday	Study day. Classes dismissed.
Jan. 16, Fri.—Jan. 24, Sat.	Semester examinations.

January 16, Friday.....Latest date for candidates for the master's degree in February to deposit theses.

January 16, Friday.....No names will be added to the February graduation list after this date.

January 24, Saturday.....Latest date for finals for Ph.D. degree in February.

January 28, Wednesday.....Latest date for candidates for Ph.D. degree in February to deposit theses and abstracts.

SECOND SEMESTER, 1958-1959

Feb. 2, Mon.—Feb. 4, Wed.....Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes will be permitted to register Saturday morning, January 31. There will be no registration on Saturday, February 7.)

February 4, Wednesday.....Latest date for registration of former students without payment of late registration fee.

February 5, Thursday.....Instruction begins.

February 13, Friday.....Applications to take French examination on February 27 will not be accepted in Graduate College Office after this date.

February 15, Sunday.....Latest date for applications for fellowships for 1959-1960.

February 20, Friday.....Applications to take German examination on March 6 will not be accepted in Graduate College Office after this date.

February 27, Friday evening.....French examination.

March 6, Friday evening.....German examination.

March 14, Saturday.....Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to "third" year.

March 16, Monday.....Latest date for adding a course to program.

March 25, Wednesday, 1 p.m.....Spring vacation begins.

March 30, Monday, 1 p.m.....Spring vacation ends.

April 10, Friday.....Applications to take French examination on April 24 will not be accepted in Graduate College Office after this date.

April 17, Friday.....Applications to take German examination on May 1 will not be accepted in Graduate College Office after this date.

April 20, Monday	Latest date for dropping a course without a grade of E.
April 24, Friday evening	French examination.
May 1, Friday	Honors Day. Classes dismissed at noon.
May 1, Friday evening	German examination.
May 15, Friday	Latest date for candidates for Ph.D. degree in June to submit theses and abstracts to Graduate College Office for approval of format.
May 22, Friday	No names will be added to the June graduation list after this date.
May 22, Friday	Latest date for candidates for the master's degree in June to deposit theses.
May 26, Tuesday	Study day. Classes dismissed.
May 27, Wed.—June 5, Fri.	Semester examinations.
May 29, Friday	Latest date for finals for Ph.D. degree in June.
May 30, Saturday	Memorial Day. No examinations.
June 3, Wednesday	Latest date for candidates for Ph.D. degree in June to deposit theses and abstracts.
June 13, Saturday	Commencement exercises.

SUMMER SESSION, 1959

June 15, Monday	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 13.)
June 16, Tuesday	Instruction begins.
June 26, Friday	Applications to take French examination on July 10 will not be accepted in Graduate College Office after this date.
July 3, Friday	Applications to take German examination on July 17 will not be accepted in Graduate College Office after this date.
July 4, Saturday	Independence Day. No classes.
July 10, Friday evening	French examination.
July 17, Friday evening	German examination.
July 20, Monday	Latest date for dropping a course without a grade of E.
Aug. 7, Fri.—Aug. 8, Sat.	Summer session examinations.
August 7, Friday	No names will be added to the Augus graduation list after this date.

August 10, Monday.....Latest date for candidates for the master's degree in August to deposit theses.

September 11, Friday.....Latest date for candidates for Ph.D. degree in October to submit theses and abstracts to Graduate College Office for approval of format.

September 25, Friday.....Latest date to file application for the master's degree in October.

September 25, Friday.....Latest date for candidates for the master's degree in October to deposit theses.

September 26, Saturday.....Latest date for finals for Ph.D. degree in October.

October 2, Friday.....Latest date for candidates for Ph.D. degree in October to deposit theses and abstracts.

NOTES

Candidates for master's degrees must submit thesis titles to the Graduate College one full semester prior to graduation date.

The two language examinations required for the Ph.D. should be passed as early as possible and must be passed in the term preceding the preliminary examination or at least two months prior to that examination.

The general thesis topic is made known to the doctoral committee at the time of the preliminary examination. The final thesis title should be submitted to the Graduate College about three months prior to the conferring of the degree.

The thesis must be submitted to the Graduate College for approval of the format at least two weeks prior to the date of the final examination.

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Physical Education	Seward Charle Staley
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Physiology	Robert Eugene Johnson
Plant Pathology	Wayne Melville Bever
Political Science	Clyde Frank Snider
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*Recreation	Charles K. Brightbill
*Social Sciences	Joseph Ward Swain
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Spanish	William Hutchinson Shoemaker
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Statistics	Mahlon Marsh Day
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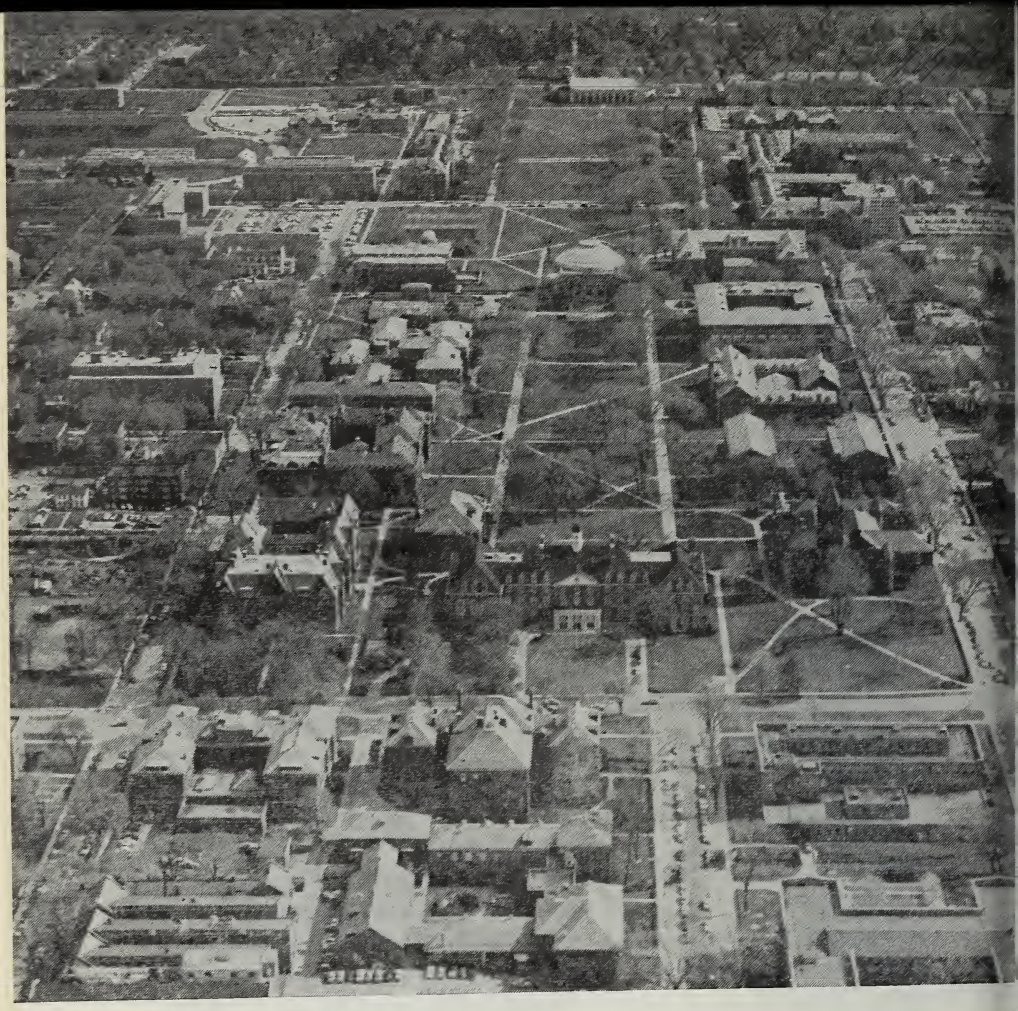

Aerial view of the campus.

The Graduate College

Graduate instruction is offered on the Urbana campus of the University of Illinois in the areas listed on pages 3 and 4 and described in more detail under the departmental listings. In addition, graduate work in the medical and dental sciences and in pharmacy is offered at the Chicago Professional Colleges. Inquiries concerning graduate work in Chicago should be directed to Dr. Milan V. Novak, Associate Dean of the Graduate College for the Chicago Professional Colleges, 808 South Wood Street, Chicago 12, Illinois.

The general requirements for admission and the degree requirements established by the Graduate College are described in this introductory section. All candidates for degrees must meet these requirements as well as those specified by the major department in the departmental listings. The degree candidate is held responsible for knowing both the general requirements of the Graduate College and the more specific ones pertaining to his major area. Every student should obtain a Graduate College catalog, a departmental bulletin, if one is issued, and a Graduate College calendar. The latter is printed each year and may be obtained at the Graduate College Office.

Admission

Procedure. A prospective student should file his application for admission at least six weeks before he expects to register. Admission forms may be obtained from the Office of Admissions and Records, 100a Administration Building, or from the Graduate College. Foreign students should request admission by letter (see page 16).

The Dean of Admissions and Records will give favorable consideration to an applicant who meets the following conditions: (1) he is a graduate of an institution awarding a baccalaureate degree comparable to that granted by the University of Illinois; (2) he is adequately prepared for advanced study as demonstrated by his previous program of study and his scholastic record; and (3) he is recommended for admission by the major department and the Dean of the Graduate College. Although the department's recommendation with respect to the admission of an applicant is based primarily on certain minimum requirements, not all who meet these standards can be admitted, since limitations in the facilities of the department concerned must be taken into consideration.

The prerequisites considered necessary for advanced work in the various fields of specialization are listed in the corresponding departmental sections of this catalog. Also listed are the scholastic grade-point averages which must be met before an application for admission is considered.

Graduate Study by Seniors at the University of Illinois. A senior who has been in residence for at least two semesters and who is within five semester hours of his bachelor's degree may be admitted to the Graduate College if his grade-point average for the last sixty hours is at least 4.0. Seniors who meet these requirements and who wish to apply should submit an application for admission to the Dean of Admissions and Records together with a letter from the dean of the undergraduate college specifying the hours needed to secure the bachelor's degree. If admitted to the Graduate College, the student must carry as miscellaneous course work the hours needed to complete the requirements for the first degree; in addition, he will register for courses to be credited toward an advanced degree.

A senior who is within ten hours of the bachelor's degree may register in graduate courses for graduate credit if his grade-point average is that specified above and if he secures the approval of the head of the major department and the instructors concerned. In all such cases, the program card must be signed by the Dean of the Graduate College before registration is completed. Graduate credit so earned does not count toward an advanced degree unless the student qualifies for admission with full standing at the close of the session and enrolls as a graduate student during the following regular semester.

Readmission. A former student who has not registered for one or more semesters must file an application for readmission. This form should be submitted to the Office of Admissions and Records several weeks before the beginning of the term in which he expects to register.

Students from Abroad. A student from abroad who wishes to be admitted to graduate study at the University of Illinois should write to the Dean of Admissions and Records, 100a Administration Building, Urbana, Illinois, enclosing copies of his academic records certified by the educational institutions previously attended. A student whose native tongue is not English is required to take an examination in English before registration. If his command of the language is not adequate, enrollment in courses for the study of English as a foreign language is required.

The Assistant Dean for Foreign Students, 152 Administration Building (West), assists students from abroad with problems involving passports, visas, and other matters.

Program of Studies

Advisers. Every graduate student must have an adviser in the department in which he is a degree candidate. The adviser's primary duty is to assist the student in planning a program of graduate work which fits the needs of the student and satisfies departmental and Graduate College requirements. A new graduate student should go to his major department to discuss the selection of an adviser.

Unit Credit for Courses. Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five. The normal program for an eight-week summer term is two units; the maximum of two and one-half units may be carried only with the approval of the adviser.

Work Completed Elsewhere. A graduate student who has done graduate work in other approved institutions for which no degree was conferred may petition to obtain credit toward an advanced degree by passing examinations in this work. Admission to such examinations requires the prior approval of the departments concerned and of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement for the master's degree.

A candidate for the doctorate must submit sixteen units of course work as one of the conditions for admission to the preliminary examination. If a master's degree was conferred elsewhere, the student does not have to submit a petition to receive credit for this work, which is considered the equivalent of eight units. If such credit is used in partial fulfillment of the requirements for the degree, the candidate is examined on the content of the courses involved at the time of the preliminary examination.

If it is recommended in advance by the major department, the Graduate College may permit a student to register for work at a laboratory elsewhere offering facilities not available at Urbana. It is understood that such work will be accepted for graduate credit if completed satisfactorily. The amount of credit to be recorded is recommended by the major department after receipt of the transcript and examination of the student.

Miscellaneous Courses. A graduate student carrying a normal graduate program may elect, in addition, one miscellaneous course (a course which does not give credit toward an advanced degree). If a graduate student enrolls for more than one miscellaneous subject, he may not register for a full graduate program. Courses intended to teach

graduate students a reading knowledge of French, German, or Russian are regarded as miscellaneous courses.

Auditing Privileges. A graduate student or a person not registered in the University of Illinois is permitted to attend classes (other than laboratory courses) as an auditor, provided a form bearing the approval of the instructor and the Dean of the Graduate College is filed with the Recorder. A student should not enter on his program card any courses which he plans to attend as an auditor.

Extramural Courses. Graduate courses in a few areas of study are offered at various centers throughout the state. A student who is employed full time may not register for more than one unit of extramural course work in any one semester nor more than one unit in any combination of extramural and campus courses.

Extramural course work is not considered as work in residence. (See residence requirements for degree desired.) Credit earned is accepted in partial fulfillment of the requirements for a master's degree only if the courses involved have been approved by the adviser.

Credit earned in extramural courses can not be applied to advanced degrees beyond the master's other than the advanced certificate.

Correspondence Courses. Credit earned in correspondence courses can not be applied to an advanced degree. However, certain prerequisites can be fulfilled or deficiencies removed through correspondence work. A catalog of correspondence courses offered by the University of Illinois may be obtained from the Division of University Extension, Correspondence Courses, 247 Illini Hall, Champaign, Illinois.

Grades. Grades are recorded by letters as follows: for courses, A (excellent), B, C, D, E (failure); for thesis research, S and U (satisfactory and unsatisfactory). Any student who receives two or more units of grade below B must replace them with additional units of A or B grade to qualify for an advanced degree. Three units of a grade below B disqualify a student as a candidate for a degree in the Graduate College.

Residence. Each degree candidate must spend a certain period of time in "residence." Residence is realized when a student lives in the community, or its immediate surroundings, and devotes an appreciable fraction of his time to graduate studies. A student who is regularly employed outside the Champaign-Urbana community is not considered to be in residence even though he is registered in a campus course.

Time Limit for Advanced Degrees.

(1) A candidate for the master's degree must complete all require-

ments for the degree within five calendar years after his first registration in the Graduate College.

(2) A candidate for the doctor's degree must complete all requirements for this degree within seven calendar years after his first registration in the Graduate College, except as noted in paragraph 3 below.

(3) A candidate for the doctorate who has received a master's degree elsewhere must complete all requirements for the degree within five years after his first registration in the Graduate College. This same regulation applies to the candidate who has received his master's degree from the University of Illinois and whose studies were interrupted immediately thereafter, provided not more than the minimum number of units required for the master's degree are applied to the doctorate.

(4) In general, the transfer of graduate credit from other institutions under circumstances not specifically defined above shall be considered a basis for proportionate reduction of the time allowed for earning a degree.

Graduate Programs for Employed Students. A student who is employed can not expect to complete his academic work as promptly as one who devotes full time to his academic program. The academic work carried by assistants and others on the University staff is limited by statute, and no deviation is permitted without compelling reasons. Those employed outside the University are expected to reduce their programs of work in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Nature of Appointment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1½ units
Two-thirds time	2½ units	1½ units
One-half time	3 units	1¾ units
One-third time	3½ units	2 units
One-fourth time	4 units	2 units

Conferring of Degrees. Advanced degrees are conferred in February, June, August, and October, except that the doctorate is not awarded in August.

Petitions. The normal procedures and requirements of the Graduate College are indicated in this catalog, but these may be modified occasionally for justifiable reasons. A student may petition to the Dean of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms may be secured at the Graduate College Office.

The Master's Degree

Master's degrees are offered in the fields indicated on pages 12 and 13. Unless otherwise specified in the departmental listings, the credit requirement for this degree is at least eight units of satisfactory course work. It is expected that three of the eight units will be in courses numbered in the 400 series, and that two of these three will be in the major field. The teacher-training curricula and certain special programs are exempt from this regulation.

Residence. A candidate must spend at least two semesters in residence and must earn at least half of the required units in residence.

Majors and Minors. A candidate for a master's degree may do all his work in one field, or he may select a major and one minor, or a major and two minors. For a master's degree a major requires a minimum of four units of work.

Foreign Language. During the first year of graduate study a student who plans to become a candidate for the Doctor of Philosophy degree should qualify in at least one of the languages required by the Graduate College.

Thesis. If a student elects to prepare a master's thesis or is required to do so by his department, he must file the subject of the thesis at the Graduate College Office one full semester prior to his graduation. No more than three units of thesis credit may be included in an eight-unit program. Credit in thesis research can not be applied to a degree unless a thesis is submitted.

For specific instructions with reference to the preparation and form of the thesis, the student should obtain at the Graduate College Office a copy of the leaflet "Instructions for Preparation of Theses."

Teacher-Education Programs. Programs leading to the master's degree for teachers in various fields are offered to students who have satisfactorily completed the four-year undergraduate teacher-training program. Students who have not met all of the requirements of a four-year undergraduate curriculum but who wish to take the fifth year of work for a master's degree may register in an approved program with the permission of the adviser and of the Coordinator of Teacher Education. Two units may be completed in extramural graduate courses. Programs for teachers are offered in the following areas, and special requirements for each are given on the page indicated:

Agricultural Education — page 40
Art — page 53
Biological Sciences and General Science — page 59
Chemistry — page 72
Commercial Teaching — page 66
Education of the Deaf — page 105
Education of Mentally Handicapped Children — page 105
English — page 128
French — page 141
Geography — page 145
German — page 152
Health Education — page 154
Home Economics — page 163
Latin — page 90
Mathematics — page 190
Mathematics and the Physical Sciences — page 191
Music — page 210
Physical Education — page 222
Physical Sciences — page 224
Physics — page 225
Social Studies — page 250
Spanish — page 265
Speech — page 269
Speech Correction — page 269

'he Degree of Doctor of Philosophy

The degree of Doctor of Philosophy is offered in the fields indicated ›n pages 12 and 13. The general requirements for the degree are described ›elow and any special departmental requirements will be found in the lepartmental listings. For information concerning the degrees of Doctor ›f Education, Doctor of Musical Arts, and Doctor of the Science of Law, ee the appropriate departmental listings.

Residence. A candidate must spend two years in residence, including wo successive semesters after the master's degree or the equivalent, ınd must complete at least sixteen units in residence.

Major and Minor Subjects. A candidate is required to declare a najor field of study and one minor (requiring four units) or two ninors (requiring two units each). If he elects two minors, only one of hem may be a division of the major department or field; a full minor nust be entirely outside the department offering the major. The requirenents for a minor in any field should be checked with the department :oncerned.

Language Requirements. A candidate is required to demonstrate ıbility to read two of the following languages: French, German, or Russian. The language requirement should be satisfied early in the loctoral program, in any event not later than two months prior to the ›reliminary examination, or during the semester (or summer session) ›receding admission to the preliminary examination. A student may ;atisfy the language requirement by direct examination or by obtaining ;rades of A or B in French, German, or Russian 401. Certification of ›roficiency in foreign languages is not accepted from other colleges or ınıversities.

Doctoral Committee. A permanent doctoral committee to conduct the preliminary and final examinations is appointed by the Dean of the Graduate College upon recommendation of the executive officer of the department in which the student is doing his major work.

Preliminary Examination. A candidate for the doctor's degree must pass a preliminary oral examination to test his knowledge of his major and minor fields of study. He is not admitted to the examination before (1) he has fulfilled the language requirement; (2) he has satisfactorily completed sixteen units of graduate work; and (3) the departments of his major and minor fields of study consider, through written examination or otherwise, that he has adequate preparation.

Final Examination. When the thesis has been completed, if the major department so recommends, the candidate is given a final oral examination by his doctoral committee. A student who has failed to maintain high standards of scholarship and research is refused admission to the final examination. Although the examination is concerned primarily with the research accomplished by the student as described in his thesis, it may extend over the candidate's whole field of study.

Thesis. The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the production of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination. The student should register for at least eight units of research credit while preparing his dissertation. Moreover, after passing his preliminary examination, he must register each semester (excluding summer sessions) until such time as he passes the final examination irrespective of how many units he may have earned.

Directions regarding thesis form and style are given in the leaflet "Instructions for Preparation of Theses," copies of which may be obtained in the Graduate College Office. Not later than two weeks before the time set for his final examination, and not later than four weeks before the time when he plans to receive the degree, the candidate must submit to the Graduate College the original and first carbon copy of his thesis. If these copies are approved as to format, they will be made available to the student, who must arrange for each member of the doctoral committee to have access to these or other copies for such time as is necessary before the date of the final examination.

Each candidate who passes the final examination must pay a $25.00 microfilm fee and deposit a typewritten abstract of his thesis of not more than six hundred words and must submit the original and first carbon of the complete thesis. The fee provides for (1) microfilming of

ıe complete thesis, with one copy deposited in the University of Illinois ıibrary, and (2) publication of the abstract in *Dissertation Abstracts.*

inancial Assistance

Opportunities for fellowships, scholarships, and both teaching and esearch assistantships are available each year to promising graduate tudents for work in any field in which the Graduate College offers an dvanced degree. The fellowship-scholarship-assistantship application orm may be obtained from the major department or from the Graduate ollege Office. To be considered for a fellowship for the following aca- emic year, an application must be returned by February 15. Scholarship nd assistantship applications are accepted after that date.

Fellowships and Scholarships. A University fellowship award pro- ides a tax-free stipend of $1,500 plus exemption from tuition and inci- ental fees for the academic year in which the fellowship is effective nd for the following eight-week summer session. A few nonresident ellowships are awarded to exceptional graduate students who have been ı residence for at least one year and who are engaged in research rojects which require direct observations or archival work elsewhere. n addition to the regular University fellowships, there are a number f industrial and endowed awards in several areas of study. Applicants or University fellowships are automatically considered for these awards. Jniversity scholarships, carrying tuition and fee exemptions only, are lso available.

Fellows and scholars are selected by the Graduate Fellowship Com- ıittee on the basis of scholarship and promise in teaching or research. ıll applicants are informed of the disposition of their applications on r about April 1. Successful applicants are expected to accept or decline y April 15. (See statement of policy adopted by the Association of ımerican Universities under assistantships on page 24.)

Assistantships. The usual academic assistantship appointment, which rovides teaching and research experience, is on a half-time basis at a alary of $1,800 for the academic year. An assistant whose salary is less han $3,600 for nine months or $4,400 for twelve months is exempt from uition and incidental fees. Assistants must carry a reduced program of tudy as shown on page 19.

Part-time appointments as student residence hall counselors are also vailable; they provide cash stipends plus room and board and the usual uition and fee exemptions. For further information, women may write o the Dean of Women, 100 English Building; men should address the upervisor of Counseling, Men's Residence Halls.

The University of Illinois adheres to the following resolutior adopted by the members of the Association of American Universitie: and a number of other graduate schools of North America:

"In every case in which a graduate assistantship, scholarship, oı fellowship for the next academic year is offered to an actual or a pros· pective graduate student, the student, if he indicates his acceptanc(before April 15, will still have complete freedom to reconsider his ac· ceptance and to accept another fellowship, scholarship, or graduat(assistantship. He has committed himself, however, not to resign ar appointment after this date unless he is formally released from it."

Libraries

The University Library's resources for advanced study and researcl are outstanding. Its present collections now exceed 3,100,000 volumes all but about 220,000 volumes being located in Urbana. The remainde are held by the Library of Medical Sciences in Chicago and the Under graduate Division in Chicago.

In addition to the figures for cataloged volumes cited above, th(University Library contains approximately 410,000 pamphlets, 190,00(maps, and 48,000 music scores and parts. More than 15,600 periodical and newspapers are currently received.

Outstanding collections have been developed for a variety of fields In the humanities, strong areas include classical literature, history, an(archeology; sixteenth and seventeenth century English literature, espe cially the Milton-Shakespeare period; nineteenth century English litera ture, American humor and folklore; French, Italian, and Spanis literature; German literature of the sixteenth and seventeenth centuries and comparative philology. In the fine arts, collections in architecture landscape architecture, and music are noteworthy.

In the social sciences, the Library's holdings are significant fo western United States history, Abraham Lincoln and the Civil Wa: Latin-American history of the Revolutionary period, Italian histor medieval and modern European history, German history for 1830-190(Irish history, international law and relations, political science, law, eco nomics, labor and industrial relations, and education.

For science and technology, collections of high rank are held i mathematics, chemistry, biological sciences (especially parasitolog entomology, and ornithology), physics, geology, engineering, and agr culture.

The Library's bibliographical facilities comprise a union catalog c more than 3,000,000 cards, representing titles owned by about tw

ozen major American and foreign libraries; printed catalogs of libraries, g., the Bibliothèque Nationale, British Museum, and Library of ongress; national and trade bibliographies of all countries for which ıch works have been issued; bibliographies of special subjects; and milar aids.

A number of departmental and divisional libraries are maintained. ollowing are the principal separately administered collections in the entral library building: Classics; Commerce, Sociology, and Social Vork; Education, Philosophy, and Psychology; English; Germanic and omance Languages; History and Political Science; Library Science; Iap and Geography; and Physical Education.

Elsewhere on the campus are departmental libraries for the follow-ıg fields: Agriculture, Architecture and Fine Arts, Biology, Chemistry, ngineering, Geology, Home Economics, Journalism, Landscape Archi-cture, Law, Mathematics, Music, Natural History Survey (entomology nd other biological sciences), Physics, and Veterinary Medicine.

Further facilities available for graduate students are free access to ıe general bookstacks, housing about 2,000,000 volumes, and over 200 ırrells in the bookstacks, assigned to individuals engaged in prolonged udy and research. Interlibrary loan service from other institutions is rovided for those engaged in research for dissertations.

pecial Laboratory Facilities

Digital Computer Laboratory. The Digital Computer Laboratory fers instruction in courses and supervision of theses for individuals ecializing in the design and use of the digital computing machinery hich is now of such importance in research work in modern technology. he Laboratory possesses the Illiac, a high-speed general-purpose com-uting machine which was built at the University of Illinois, and is vailable to the members of the staff of the University of Illinois for lving their scientific problems. This computational facility of the aboratory will be supplemented during the academic year 1958-1959 y having an IBM 701 computer installed and operated in addition to liac. This expansion is due in part to the fact that the work of the aboratory and the University in the area of data processing is expand-ıg. Members of the staff who are engaged in computer research gularly offer seven courses: Mathematics 385, 387, and 457, Mathe-ıatics-Electrical Engineering 384, 391, and 392, and Mathematics-gronomy 365. There is also a weekly seminar (no credit). Descriptions these courses are given under the appropriate department headings.

Although no advanced degree is offered by the Digital Computer

Laboratory, candidates for advanced degrees in electrical engineering, mathematics, or physics who are interested in this area of study may engage in thesis work under the supervision of one of the staff members in the Laboratory.

The Laboratory is actively engaged in the construction of a very high-speed computer (between 100 and 200 times faster than Illiac) of its own design. Design and construction studies are presently underway. This is in addition to the research being carried out in Boolean algebra of switching circuits, applied mathematics, computer circuits, and high speed memories. A limited number of research assistantships are available for work carried out in the Laboratory. Requests for additional information concerning the work in the Laboratory and applications for assistantships should be directed to the head of the Digital Computer Laboratory.

Electron Microscope Laboratory. The Electron Microscope Laboratory is devoted to research work in behalf of all University departments. It is equipped with four different types of RCA electron microscopes, the original EMB, EMC (Console Type), EMT (table model with permanent magnet lenses), and a new EMU of latest design. These four microscopes with all auxiliary equipment are permanently located in an air-conditioned laboratory and their operation is under the direction of an expert electron micrographer. A seminar in electron microscopy is also offered for the purpose of training qualified graduate students from all departments in the technique.

Physical Environment Unit. The facilities of the Physical Environment Unit include rooms and an altitude chamber, in which ranges of temperature, humidity, and pressure can be controlled, and basic medical and physiological instruments. They are available for use by any department or division of the University needing controlled environmental conditions for special research or instructional work. Although primarily designed for studies with human subjects and animals, the facilities can also be used for limited engineering and physical science activities.

Research assistantships, while not available in the Physical Environment Unit, are available in some of the departments interested in the effects of environment on people and animals. Inquiries regarding such assistantships should be sent to the department offering the specific work in which the student is interested.

Radiocarbon Laboratory. The Radiocarbon Laboratory, an a university facility maintained and directed by a permanent staff, conducts research on chemical, physical, and biological problems by

f the tracer technique with carbon-14. Modern radiochemical equipment for the synthesis, degradation, isolation, and assay of radioactive arbon compounds is available.

A carbon-14 course, Chemistry 496 and Animal Nutrition 496, introducing radioactive carbon as a unique and potent tool of investigaon and emphasizing experimental techniques, is conducted by the aff one semester each year and is a prerequisite for student research the Laboratory.

ees and Expenses

Students registering for resident work pay fees each semester or mmer session according to the following schedules:

MESTER TUITION AND FEES

Payable in full when the student registers)

uition Fee (except those holding scholarships)

	Regular Schedule (Over two units)	*Reduced Schedule (Two units or less)*
Residents of Illinois	$ 75.00	$24.00 per unit
Nonresidents of Illinois	250.00	80.00 per unit
boratory, Library, and Supply Fee	11.00	5.50
ospital and Medical Service Fee	7.00	7.00
All students, including persons on part-time appointment on the University staff or the staffs of the allied surveys or laboratories, are subject to this fee. Students who present evidence of participation in any other group insurance system providing the same benefits as those covered by the University fee may petition through the University insurance office for a refund of this fee. *Students registered for one unit or less are exempt from this fee.*		
ini Union Service Charge	7.00	7.00
Students registered for one unit or less are exempt from this fee.		

MMER SESSION TUITION AND FEES

ayable in full when the student registers)

ition Fee (except those holding scholarships)

	Regular Schedule (Over one unit)	*Reduced Schedule (One unit or less)*
Residents of Illinois	$ 37.50	$24.00 per unit
Nonresidents of Illinois	125.00	80.00 per unit

Laboratory, Library, and Supply Fee	5.50	2.75
Hospital and Medical Service Fee	3.50	3.50
Students registered for one-half unit or less are exempt from this fee.		
Illini Union Service Charge	3.50	3.50
Students registered for one-half unit or less are exempt from this fee.		

SPECIAL FEES

Late Registration Fee ..... $ 5.00

Former students, whether on appointment or not, who register after the regular registration days in either semester are subject to this fee.

Change of Program Fee 1.00

This fee is charged for every change slip issued at the request of the student after the completion of registration.

"In Absentia" Registration

Students enrolled for credit in thesis work for the master's or doctor's degree on leave of absence pay only the regular tuition fee, resident or nonresident, as listed above.

Registration for 0 Credit

Candidates for the doctor's degree, resident or nonresident, enrolled in thesis-research work for 0 credit pay each semester a flat fee of... 6.0
($4.00 each term at the Chicago Professional Colleges)

Listener's Fee 10.0

Persons who attend classes as listeners, except those on University appointment and students registered for a full schedule, pay this fee for each course.

Flight-Training Fee ..... 275.

Students taking flight-training pay this materials and supply fee for each flight-training course.

Extramural Courses

Credit courses

Tuition fee for each unit ..... 24.
Laboratory, Library, and Supply Fee ..... 5.

Noncredit courses

Registration fee for a one-hour course 11
Two hours, $17.50; three hours, $23.50.

Off-Campus Courses (field courses and social work courses in Chicago)

Students pay the regular tuition fee, the laboratory, library, and supply fee, and the hospital and medical service fee. Students in social work courses in Chicago registered for more than one unit of graduate credit in any semester pay an Illini Union service charge of $5.25. Students in field courses are exempt from the Illini Union service charge.

Recreational Sports Fee

Visitors pay each semester..... 12.00
For the summer term, $6.00.

Wives or husbands of students and members of the faculty pay each semester..... 6.00
For the summer term, $3.00.

Transcript Fee 1.00

Each student who has paid all his University fees is entitled to receive, without charge, one transcript of his record. For each additional transcript the fee is $1.00.

Service Charge for Deferred Fees

A service charge of ten per cent of the amount of fees deferred, but not less than $1.00 nor more than $3.00 a semester, is assessed for the privilege of deferring fees. If the deferred amount is paid in full within ten days of first and second semester registration or five days of summer session registration, the service charge is refunded except that a minimum service charge of $1.00 is retained by the University in all cases. The hospital and medical service fee, the Illini Union service charge, the service charge for deferring fees, and all charges from previous semesters must be paid on the day of registration.

EXEMPTION FROM FEES

Holders of scholarships and fellowships awarded by the Graduate College are exempt from tuition and incidental fees, except the hospital and medical service fee, for the academic year and the summer session immediately following.

The following persons may register in University courses for which they are eligible for admission without payment of the tuition fee, the laboratory, library, and supply fee, and the Illini Union service charge, provided their annual salary for nine months is *less than* the minimum salary established for full-time assistants ($3,600.00 for nine months; $4,400.00 for twelve months): members of the academic or administrative staffs of the University in any capacity; members of the nonacademic staff who are on permanent appointment, provided they obtain approval in advance from the head of their department and the Director of Nonacademic Personnel.

Members of the academic and administrative staffs exempt from fees as indicated above during the second semester of the academic year are exempt also in the summer session immediately following termination of their appointments.

Permanent nonacademic employees without regard to salary may register without payment of any fees or deposits under the following conditions: (1) in any regular University course in which the employee is requested by the department with the concurrence of the Director of Nonacademic Personnel to enroll or the improvement of the employee's present work, or (2) in any special course looking toward improving University service organized at the request of the Director of Nonacademic Personnel in cooperation with the teaching staff, the employee concerned, and the department in which such employee is located.

REFUNDS OF FEES

In case a student withdraws from the University during the first ten days of instruction in any semester, the total amount of his fees, except the hospital and medical service fee, is refunded. After ten days and before the middle of the semester, a rebate of one-half of the fees is made. After the middle of the semester, no rebate is allowed. In the summer term, for students registered for eight weeks, the total amount of fees paid, except the hospital and medical service fee, is refunded if withdrawal occurs within the first five days; one-half the amount after the first five days but within the first four weeks; and nothing after the beginning of the fifth week.

EXPENSES

Although personal expenses may vary a great deal, the following estimates indicate the average cost for students: board, $15.00 to $18.00 a week; room rent, single rooms from $25.00 to $35.00 a month; double rooms from $20.00 to $25.00 a month for each person.

Housing

The University does not operate residence halls for graduate students. However, a limited number of one-room efficiency apartments for married students is available in the University-owned Student-Staff Apartment Building. Applications for these units may be obtained from the Housing Division, 108 Illini Hall, or the Graduate College. In addition, the Director of the Housing Division maintains a list of apartments and rooms available in private homes in the community.

Fields of Instruction

Courses open to graduate students are of two classes. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only.

Many courses for graduate students require some measure of previous preparation. By consultation with the instructor, a student may learn whether he has had the necessary prerequisites for a particular course.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Accountancy and Master of Accounting Science.

The minimum grade-point average for admission to graduate study in accountancy is 3.5.

Candidates for the Master of Science degree must have had the equivalent of twenty hours of undergraduate work in accountancy and at least one course each in principles of economics and finance. Candidates for the Master of Accounting Science degree, emphasizing professional training in public, industrial, or governmental accounting, must have had at least twenty-four hours of undergraduate work in accountancy, including courses in cost accounting, federal income tax accounting, auditing, and advanced problems. Graduate students in other departments who choose accountancy as a minor must present similar courses, with fifteen instead of twenty hours in accountancy as a minimum. Students who can not meet these requirements are expected to remove any deficiencies during the first year of residence by taking prescribed courses without graduate credit.

Students who have received undergraduate degrees from colleges other than colleges of commerce and business administration and who have had no undergraduate work in accountancy may also remove deficiencies during the first year of residence. Courses without graduate credit are available which permit such students to remove deficiencies in one year. It is then possible for these students to earn a Master of Science degree in accountancy during the second year of residence. Requests for further information should be addressed to the head of the department.

A first-year student whose major is accountancy ordinarily is expected to take Accountancy 481 and 483. In addition, candidates for the degree of Master of Accounting Science are required to register in Accountancy 494. The candidate for the Master of Accounting Science degree must select one or more minors of one to four units in a field or fields outside the area of accountancy. The minor field or fields to be selected and the number of units are determined in consultation with the adviser, and depend upon the undergraduate background of the student, his educational objective, and other factors.

A student who wishes to become a candidate for the Doctor of Philosophy

degree with a major in accountancy must pass a preliminary examination showing a thorough knowledge of accounting theory; a thorough knowledge of certain areas of accountancy, the number and selection of which are to be determined by the adviser in consultation with the student; a general acquaintance with the subject matter and bibliography of other areas of accountancy; and proficiency in the field or fields outside the department offered as a minor or minors.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in accountancy may be obtained from the head of the department, 321 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professors: C. A. Moyer (Head of Department), N. M. Bedford, R. I Dickey, G. E. Lukas, R. K. Mautz, H. L. Newcomer, W. E Thomas, N. D. Wakefield.

Associate Professors: G. D. Brighton, C. H. Griffin, Dorothy Litherland K. W. Perry, A. R. Wyatt.

Assistant Professors: E. J. DeMaris, R. E. Schlosser, D. H. Skadden, V. K Zimmerman.

COURSES FOR GRADUATES

401. **General Accounting Theory.** For non-accountancy majors. A general presen tation of accounting divested of the technicalities of bookkeeping, cost ac counting, auditing, income tax procedure, so that it may provide graduat students, who have had or will secure a minimum of technical preparatio in the subject, with a useful understanding of its basic ideas and limitation I; 1 unit. Prerequisite: Consent of instructor. Litherland.

424. **Specialized Systems.** Accounting procedures used by industrial and mercar tile enterprises in handling their special problems; study of uniform accoun ing systems. I; 1 unit.

441. **Governmental Accounting.** Advanced study in accounting and other fisc procedures of the federal government; state, county, and municipal gover ments; institutions. I; 1 unit. Lukas.

461. **Administrative Accounting.** Accounting as a tool for management: organ zation of accounting department, coordination of departmental operation control of assets, control of operations, management audits, accounting a pects of coordinating the business with market conditions, cooperation wi public accountants and government agencies, and social responsibilities. 1 unit. Thomas.

466. **Cost Accounting.** A critical examination of cost accounting methods as truth and expediency. I; 1 unit. Dickey.

471. **Accounting Reports.** Form, contents, certificates, comments, consolidat statements, auditor's rights and responsibilities, published corporation r ports. II; 1 unit. Wakefield.

472. **Auditing Standards and Techniques.** A critical analysis of the techniqu used in auditing; interrelation of audit standards, procedures, principles, a techniques; internal control as related to audit techniques; trends and c velopments in the accounting profession. II; 1 unit. Mautz, Moyer.

473. **System Design and Installation.** Problems and procedures in connection wi designing and installing accounting systems. II; 1 unit. Schlosser.

474. **Income Tax Development.** A theoretical and historical approach to the stu of the development of federal income taxation, together with some resear

on tax cases and critical appraisal of the current law and proposals for its revision. II; 1 unit. SKADDEN.

477. **Professional Problems.** Instruction as to types and methods of solution of professional problems in public accounting, including practice in analyzing and solving a wide variety of such problems. II; 1 unit. STAFF.

481. **Concepts and Principles.** The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. I; 1 unit. BEDFORD, MOYER, WYATT.

483. **Income Determination.** A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. II; 1 unit. BEDFORD, MAUTZ, PERRY.

484. **The Accounting Theory of Business Income.** An examination of the development and essential characteristics of the accounting theory of business income evaluated in the light of criticisms implicit in other concepts of income; the social significance of business income theory. I; 1 unit. MAUTZ.

487. **Surplus and Dividends.** The theories underlying the treatment of balance sheet items deserve close consideration in accounting, because the balance sheet reflects the effect of conflicting ideas about the bases for setting up restrictions on the freedom of directors to dispose of corporation assets as dividends. II; 1 unit. NEWCOMER.

489. **History of Accounting Theory.** An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. II; 1 unit. LITHERLAND.

493. **Special Research Problems.** Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. I, II; ¼ to 2 units. MOYER.

494. **Methods and Practices in Professional Research.** Instruction in research methods, materials, and techniques together with individual practice in conducting and reporting on specific professional research projects. I, II; 1 unit. STAFF.

499. **Thesis Research.** Individual direction and guidance in writing theses, and seminar discussions of progress made. I, II; 0 to 4 units. BEDFORD, MAUTZ, and others.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Advanced Accounting.** Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. I, II; ¾ unit. Prerequisite: Accountancy 106 and 108. BEDFORD, GRIFFIN, NEWCOMER, SKADDEN.

324. **Accounting Systems.** A discussion of the systems used by contractors, department stores, finance companies, building and loan associations, banks, insurance companies, brokers, water companies. I, II; ½ unit. Prerequisite: Accountancy 106 and 108. SCHLOSSER.

341. **Governmental Accounting.** Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. I, II; ½ unit. Prerequisite: Accountancy 108. BRIGHTON, LUKAS.

362. **Business Budgets and Accounting Control.** Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. I; ¾ unit. Prerequisite: Accountancy 108. THOMAS.

366. **Advanced Cost Accounting.** Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. I, II; ½ unit. Prerequisite: Nine hours of accountancy, including Accountancy 106. DICKEY, THOMAS.

371. **Auditing.** Ethics of the accounting profession; auditing standards and procedures; programs of audit of various accounts; construction and indexing of working papers; report to clients. I, II; ¾ unit. Prerequisite: Accountancy 308. DEMARIS, MAUTZ, WYATT.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. I, II; ¾ unit. Prerequisite: Accountancy 371. MOYER, WAKEFIELD, WYATT.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. II; ¾ unit. Prerequisite: Accountancy 274 and 308. BRIGHTON, SKADDEN.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. I, II; 1 unit. Prerequisite: Credit or registration in Accountancy 371. GRIFFIN, NEWCOMER, WAKEFIELD.

378. **C.P.A. Problems.** Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory, auditing, ethics. I, II; 1 unit. Prerequisite: Accountancy 377. NEWCOMER, PERRY.

Note: See also Business Administration 373, Electronic Data Processing for Business.

AERONAUTICAL ENGINEERING

The Department of Aeronautical Engineering offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. The principal fields of study are aerodynamics, aircraft propulsion, and aircraft structures. Programs of study and research are selected to prepare graduates for airplane, missile, and space flight engineering.

The minimum grade-point average for admission to graduate study in aeronautical engineering is 3.75.

The prerequisite for graduate study in aeronautical engineering is normally the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in aeronautical engineering. It is expected that graduate students with deficiencies in their aeronautical engineering background will demonstrate proficiency in the fundamentals of their chosen field by passing suitable courses or examinations to the satisfaction of their advisory committees.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Students plan their study programs in consultation with departmental advisory committees. Courses offered by departments other than aeronautical engineering may be included in the major area of study when these courses are of particular value to the work which

students desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical engineering must have taken mathematics through the first course in differential equations and undergraduate aeronautical engineering courses, equivalent to those offered at the University of Illinois, which are prerequisites to study in the branch of the subject in which the minor work is to be pursued. Where special cases warrant deviation from these requirements, approval from the head of the department is required.

For information concerning applied mathematics, see page 196.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in aeronautical engineering may be obtained from the head of the department, 101 Transportation Building.

GRADUATE TEACHING FACULTY

Professors: H. S. Stillwell (Head of Department), J. M. Coan, H. H. Hilton, M. Z. Krzywoblocki, R. W. McCloy, A. I. Ormsbee.
Associate Professor: B. L. Hicks.

COURSES FOR GRADUATES

410. **Non-Steady Aerodynamics.** Aerodynamic characteristics of aircraft components in non-steady motion, including the aerodynamics of flutter and buffeting, and internal non-steady flow phenomena. II; 1 unit. Prerequisite: Aeronautical Engineering 216; Mathematics 346 or 348; consent of instructor. Ormsbee.

411. **Advanced Aerodynamics of Compressible Fluids.** Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. I; 1 unit. Krzywoblocki.

412. **Theory of Turbulence.** Introduction to the classical and modern theories of turbulence: Reynold's, Prandtl's Kármán's, Kármán-Howarth's, Kolmogoroff's, Heisenberg's, Krzywoblocki's theories in compressible fluids; Kampe de Feriet's theory. II; 1 unit. Prerequisite: Consent of instructor. Krzywoblocki.

414. **Advanced Theory of the Boundary Layer, Wakes and Jets.** The modern concepts and solutions of the boundary layer theory (laminar and turbulent), including considerations of transition and stability as well as the applications to wake and jet theories. II; 1 unit. Prerequisite: Consent of instructor. Krzywoblocki.

415. **Wing Theory.** Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple body systems in subsonic and supersonic flow. I; 1 unit. Prerequisite: Mathematics 346 or equivalent. Ormsbee.

417. **Newtonian Flow and Elements of Missile Ballistics.** Fundamental concepts of Newtonian fluids; surface temperature of bodies in free molecular flow; equations of motion of a rocket during and after burning; properties of rocket functions; terrestrial and extra-terrestrial dynamics of rockets. II; 1 unit. Prerequisite: Aeronautical Engineering 306 and 411, or consent of instructor. Krzywoblocki.

421. **Advanced Aircraft Shell Structures.** Shear lag and diffusion of load in stiffened panels; relaxation methods; restrained warping of stiffened boxes with and without cutouts; exact and energy solutions for buckling of

non-uniform columns, continuous columns, and plates. II; 1 unit. Prerequisite: Aeronautical Engineering 222 or consent of instructor. COAN.

426. **Theory of Continuous Media.** Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; nonlinear strain relations; nonlinear equilibrium conditions; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. II; 1 unit. Prerequisite: Consent of instructor. HILTON.

427. **Thermal Stresses and Creep Buckling.** Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating of plastic and linear and nonlinear viscoelastic columns, plates, and shells; life expectancy of structures under elevated temperatures; applications to high speed airplane and missile structures. I; 1 unit. Prerequisite: Aeronautical Engineering 426 or consent of instructor. HILTON.

431. **Aerothermodynamics.** The fundamental principles of kinetic theory and of classical and statistical thermodynamics are reviewed as a basis for treating the gas imperfection, dissociation, chemical reactions, transport properties, and relaxation phenomena which occur in aerodynamic and combustion problems. I; 1 unit. Prerequisite: Aeronautical Engineering 216 and 233 and one physics course beyond general physics, or equivalent. HICKS.

451. **Aeroelasticity and Aeroinelasticity.** Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. II; 1 unit. Prerequisite: Aeronautical Engineering 250 or consent of instructor. HILTON.

490. **Seminar.** Presentation by graduate students and staff of current topics in the fields of aeronautics. I, II; 0 units. Prerequisite: Graduate standing in aeronautical engineering. ORMSBEE.

493. **Special Problems.** Theoretical and experimental investigations of problem in airplane, missile, and space flight engineering. I, II; 1 to 2 units. STAFF

499. **Thesis Research.** Research in the various areas of the aeronautical sciences I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Foundations of Mechanics and Gravitational Theory.** Same as Astronom 306. Introduction to the dynamics of particles and of rigid bodies wit special emphasis on elementary planetary motion, motion of a rocket, motio of long-range projectile relative to earth, precession of earth's axis, etc. I c II; 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE.

311. **Aerodynamics of Perfect Fluids.** Fundamental equations; plane irrotation flow; vortex flow; combination fields of flow; Kutta-Joukowski theoren application of conformal transformation to fields of flow; particle paths; fiel of flow relative to axes fixed in fluid; velocity potential; three-dimension fields. I; ½ unit. Prerequisite: Aeronautical Engineering 211. KRZYW BLOCKI.

334. **Rocket Propulsion and Rocketry.** The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. II; ½ unit. Prerequisite: Mechanical Engineering 205 or equivalent, or consent of instructor. McCloy.

391. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. I; ½ to 1 unit. Prerequisite: Consent of instructor. Staff.

392. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. II; ½ to 1 unit. Prerequisite: Consent of instructor. Staff.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the degrees of Master of Science and Doctor of Philosophy. The chief fields of specialization are farm management, land economics, marketing, prices and statistical analysis, and rural sociology. Graduate work is also offered in national agricultural policies and programs, finance, law as applied to agriculture, and in international comparative agriculture.

Students who desire to secure degrees in agricultural economics must have completed either (1) a course of study equivalent to that required for the degree of Bachelor of Science in Agriculture at the University of Illinois, and including twelve hours of agricultural economics and economics, or (2) twelve hours of undergraduate economics and agricultural economics, and at least eight hours in accountancy, business law, history, management, marketing, political science, and sociology. See also the requirements which must be met in order to take economics as a minor.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

The minimum grade-point average for admission to graduate study in agricultural economics is 3.5.

A candidate for the degree of Master of Science is required to register for at least two units in economics, including one unit of economic theory. For the degree of Doctor of Philosophy, he must complete a minimum of five units in the College of Commerce and Business Administration, including three units in economics, two of which must be in economic theory at the 400 level. One unit of research methodology and one unit of statistical methods, both at the 400 level, are required.

If approved by the Department of Agricultural Economics and the Dean of the Graduate College, the required work in economics may be treated as a part of the major field. Otherwise, the work in economics is considered a first minor, in which case the program in that minor requires the approval of the Department of Economics (see requirements in economics for a minor in that field).

To take agricultural economics as a minor, the student must have had at least twenty hours of undergraduate work in economics and agricultural subjects.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in agricultural economics may be obtained from the head of the department, 305 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: H. G. Halcrow (Head of Department), R. W. Bartlett, H. W. Hannah, G. L. Jordan, D. E. Lindstrom, R. C. Ross, C. L. Stewart, J. E. Wills.

Associate Professors: C. B. Baker, E. E. Broadbent, W. D. Buddemeier, C. L. Folse, T. A. Hieronymus, R. A. Kelly, N. G. P. Krausz, R. J. Mutti, E. R. Swanson, W. N. Thompson, V. I. West.

COURSES FOR GRADUATES

404. **Economics of Agricultural Production.** Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. II; 1 unit. Swanson.

405. **Economic Policies and Programs Affecting Agriculture.** Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. I; 1 unit. Prerequisite: One semester of graduate work or consent of department. Halcrow.

406. **Research Methodology in Agricultural Economics.** Methods of inquiry leading to information which is reliable and relevant to the solution of problems significant in the agricultural economy. II; 1 unit. Prerequisite: Economics 400 or 401 or a course of comparable level in the basic field related to the student's research. Baker.

418. **Land Economics.** Land classification methods and principles; land tenure systems in modern societies; land deterioration and restoration as private and public problems. II; 1 unit. Stewart.

425. **Farm Management Principles.** Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. Field trip; estimated expense, $8.00. I; 1 unit. Wills.

436. **Problems in Marketing Agricultural Products.** Factors influencing growth of markets; methods of reducing costs and improving marketing processes; activities of government agencies; cooperative efforts. II; 1 unit. Hieronymus.

441. **Agricultural Statistics.** Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. I; 1 unit. Prerequisite: An elementary course in statistics. West.

442. **Agricultural Prices.** Prices of agricultural products in the light of their history, value theory, monetary theory, and methods of statistical analysis. II; 1 unit. Prerequisite: Agricultural Economics 441; a course in economic theory. West.

491. **Seminar and Special Topics.** Each graduate student whose major is agricultural economics must register in this course. These or other students who complete special studies under the direction of staff members receive credit. I, II; 0 to 2 units.

499. **Thesis Research.** Only those students who submit an acceptable thesis receive credit. I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Financing Agriculture.** Capital and credit needs of farmers; agencies supplying credit needs; problems of borrowers and lenders. II; ½ unit. Prerequisite: Economics 102 and 103, or 108. Jordan.

303. **Agricultural Law.** Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, taxation, and other problems involving agriculture. I, II; ½ unit. KRAUSZ.

305. **Agricultural Development and Policies.** Agricultural development in the United States presented as a basis for analyzing the effectiveness of past agricultural policies, delineating agricultural problems, and the need for developing sound agricultural policies in keeping with a sound national economy. I; ½ unit. THOMPSON.

312. **Farm Appraisals.** Same as Agronomy 312. Valuation of farm real estate; soils, crops, management, buildings, drainage, land titles, prices, and taxes in relation to value. Local field trips; estimated expense, $7.00. II; 1 unit. Prerequisite: Agronomy 201 and Agricultural Economics 220, or equivalent. STEWART and others.

324. **Farm Operation.** Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5.00. II; ½ unit. Prerequisite: Agricultural Economics 220. WILLS.

325. **Advanced Farm Management.** Functions of management; planning for conservation and profit; fitting the livestock organization to the kind of crops produced and to market outlets; economic information for farm planning; measures of farm efficiency; labor and power problems. Field trips to study successful farms; estimated expense, $10.00. I; ½ to 1 unit. Prerequisite: Agricultural Economics 220. BUDDEMEIER.

331. **Grain Marketing.** Same as Marketing 331. Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially futures markets; inventory management; operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. I; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or consent of instructor. HIERONYMUS.

332. **Livestock Marketing.** Same as Animal Science 332 and Marketing 332. Problems and practices in marketing livestock. Field trip; estimated expense, $7.00. II; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or consent of instructor. BROADBENT.

333. **Marketing Horticultural Products.** Same as Horticulture 333 and Marketing 333. Products and their utilization; institutions, functions, and agencies; merchandising methods; economic problems involved in horticultural marketing. I; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or five hours of horticulture, or consent of instructor. KELLY.

334. **Marketing Dairy Products.** Same as Dairy Science 334 and Marketing 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5.00. II; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

337. **Economic History of American Agriculture.** Same as Economics 337 and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. Graduate students who take this course for one unit credit are required to do extra work. The student writes a scholarly paper on some approved topic in agricultural history. I; ½ or 1 unit. Prerequisite: A college level course in basic economics or American history. JONES.

341. **Agricultural Statistics.** Statistical methods with special application to agricultural problems, including price behavior. Students receiving credit in this course will not receive credit in Agriculture 216. I; ½ unit. West.

342. **Agricultural Prices.** A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. Jordan.

Rural Sociology

COURSES FOR GRADUATES

407. **Topical Seminar in Rural Sociology.** Same as Sociology 407. Analysis of topics of special interest such as population, migration, rural cultural change, rural culture and personality development, rural regions, and comparative rural societies. I; 1 unit. Prerequisite: Twelve hours of social science or introductory statistics, or consent of instructor. Staff.

477. **Rural Communities.** Same as Sociology 477. A study of rural community structure, functions, and processes, to give the student a concrete picture of how rural communities operate, and the forces which cause change in the group life of the people living in a rural community. Field trip; estimated expense, $5.00. II; 1 unit. Lindstrom.

487. **Special Problems in Rural Sociology.** Same as Sociology 487. I, II; ½ to 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

317. **Structure and Function of Rural Society in America.** Same as Sociology 317. A functional analysis of the group, institutional, and class structure of contemporary American rural society, with emphasis on regional and subregional variations and the interdependence of the rural and other segments of the total American society. I; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Three hours of sociology, eight hours of social science, or consent of instructor. Folse.

377. **Rural Community: Organization and Analysis.** The nature of the town-country community with special emphasis on its structure and organization, the institutional and agency programs and their leaders. Designed specifically for students preparing for vocational agriculture, extension, and other private and public agency work in rural areas. I; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Three hours of sociology or eight hours of social science, or consent of instructor. Folse.

AGRICULTURAL EDUCATION

This is a program leading to the degree of Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching vocational agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of vocational agriculture, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Education 311 and 312 and two of the following courses: Education 301, 302, 303, 304. The courses in

agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department. A program of study suited to the student's objective is suggested by the adviser from courses listed under the departmental headings.

The minimum grade-point average for admission to graduate study in agricultural education is 3.5.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall, Professor H. M. Hamlin, 103 Gregory Hall, and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

The Department of Agricultural Engineering offers graduate work leading to the degree of Master of Science in Agricultural Engineering, with options for specialization in farm power and machinery, soil and water control, farm structures, rural housing, and rural electrification.

Candidates for the master's degree must have had the equivalent of the undergraduate curriculum at the University of Illinois. This specifically includes sound training in engineering fundamentals and at least twelve semester hours of advanced undergraduate engineering design courses.

The minimum grade-point average for admission to graduate study in agricultural engineering is 3.5.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in agricultural engineering may be obtained from the head of the department, 206 Agricultural Engineering Building.

GRADUATE TEACHING FACULTY

Professors: F. B. Lanham (Head of Department), E. L. Hansen, R. C. Hay, K. H. Hinchcliff, G. E. Pickard.
Associate Professors: D. F. Kampe, R. R. Yoerger.
Assistant Professors: R. M. Peart, J. H. Ramser, J. A. Weber.

COURSES FOR GRADUATES

336. **Dynamics of Farm Machine Elements.** Advanced study of the dynamics of farm machine elements with specific reference to functional operation, stresses and fatigue life. I; 1 unit. Prerequisite: Agricultural Engineering 236 and 336, or equivalent. Pickard.

346. **Farm Tractors.** A study of research findings that apply to farm tractors including tests of tractors and component parts, evaluation of transmission designs, travel efficiency, tractor stability and horsepower hour requirements for farm tractor operations. II; 1 unit. Prerequisite: Agricultural Engineering 346. Weber.

471. **Farm Structures in Agricultural Production.** Farm structures as related to production, farm operation, and systems of farming; building management, functional requirements, cost and appraisal. Discussions, problem study, and reports. I; ½ unit. Prerequisite: Bachelor's degree in agriculture. HANSEN.

496. **Problems in Agricultural Engineering.** Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. I, II; 1 unit. Prerequisite: Bachelor's degree in agricultural engineering or other engineering curriculum, with credit in courses essential to the optional line of study; consent of head of department. STAFF.

499. **Thesis Research.** I, II; 1 to 2 units. STAFF.

COURSES FOR ADVANCED UNDERGRADUATES AND GRADUATES

300. **Special Problems.** An agricultural problem with engineering implications is selected for study, investigation, and report wherein a satisfactory solution does not require a background of engineering education. For non-engineering students only. I, II; ½ unit. Prerequisite: Senior standing; approval of head of department. STAFF.

331. **Function, Application, Adjustment, and Management of Farm Machinery.** A study of field and farmstead machinery as related to the needs of agricultural production, systems of farming, function, construction, maintenance, and operation costs. S; ½ unit. Offered in 1959 and in alternate years. Prerequisite: Agricultural Engineering 112 or 131, or consent of instructor. PICKARD.

336. **Design of Agricultural Machinery.** Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of design to problems. II; ½ unit. Prerequisite: Mechanical Engineering 271. KAMPE.

346. **Farm Power.** Basic theory, analysis, and testing of internal combustion engines specifically for use in farm tractors, and other farm power application. I; ½ unit. Prerequisite: Mechanical Engineering 209. WEBER.

351. **Hydraulics of Soil Conservation.** Hydrology, hydraulics, design, construction, and cost estimates of erosion control structures, water conservation dams, agricultural drainage systems, and soil conservation practices; relationships of slopes, soils, crops, and practices. Lectures, field trips, and problems. I; ½ unit. Prerequisite: Civil Engineering 215; Theoretical and Applied Mechanics 232 and 234; senior standing in agricultural engineering or consent of instructor. HAY.

355. **Advanced Soil and Water Conservation Practices.** A study of conservation practices and their evaluation in relation to farm operations; planning, constructing, and checking of terraces, waterways, diversion ditches, and drainage systems. II; ½ unit. Prerequisite: Agricultural Engineering 111 or 252, or consent of instructor. HAY.

356. **Soil Conservation Structures.** Hydrology, hydraulics, design, construction, and cost estimating of soil and water conservation structures; relationship of slopes, soils, crops and practices in soil conservation and flood control. II; ½ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234; registration in Civil Engineering 263.

357. **Land Drainage.** The design, construction, performance, and maintenance of surface tile and open ditch drainage systems. I; ½ unit. Offered in 1959-1960 and in subsequent years. Prerequisite: Theoretical and Applied Mechanics 232 and 234.

361. **Development and Function of Family Housing.** Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure, economic influences, costs, and adaptations; personal and public interests. II; ½ unit. HINCHCLIFF.

371. **Advanced Farm Structures.** II; ½ unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223; Civil Engineering 261; senior standing. HANSEN.

376. **Advanced Design of Farm Structures.** Timber, steel, and concrete building design, with emphasis on structures for agricultural production. II; ½ unit. Prerequisite: Credit in Civil Engineering 262 and 263. HANSEN.

381. **Farm Electrical Equipment.** Advanced course. Exploration and evaluation of the factors involved in the selection, arrangement, installation, and operation of equipment for applying electricity to farming operations. II; ½ unit. Prerequisite: Agricultural Engineering 241 or graduate standing in agriculture, or consent of instructor. PEART.

387. **Agricultural Process Engineering.** Principles, design factors, equipment, and controls of systems for drying, refrigerating, reducing, pelleting, blending, cleaning, sorting, and treating agricultural crops and products. II; ½ unit. Prerequisite: Agricultural Engineering 286 or Chemical Engineering 363. LANHAM.

396. **Special Problems.** An agricultural problem is selected for study, investigation, and report wherein a satisfactory solution requires a strong background of engineering education. I, II; ½ unit. Prerequisite: Senior standing in engineering. STAFF.

AGRONOMY

The Department of Agronomy offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, crop production, ecology, experimental design, forage crops, morphological development, physiology, plant chemistry, weeds and their control; or (2) soils: biology, chemistry and biochemistry, fertility, genesis and classification, management, physical and colloidal chemistry, physical edaphology, physics.

The minimum grade-point average for admission to graduate study in agronomy is 3.75.

Fifteen semester hours in agronomy and related subjects are prerequisite for a minor and five additional hours for a major, but students with an unusually broad and thorough training in science may be exempted from certain of these requirements.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, bacteriology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics. A pamphlet giving specific prerequisites and requirements may be obtained from the head of the Department of Agronomy.

A candidate for the Master of Science degree must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units fulfill the requirements for a first minor for the Doctor of Philosophy degree.

More detailed information may be obtained by writing to the Department of Agronomy.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in agronomy may be obtained from the head of the department, 216 Davenport Hall.

GRADUATE TEACHING FACULTY

Professors: M. B. Russell (Head of Department), O. T. Bonnett, R. H. Bray, E. B. Earley, J. E. Gieseking, J. A. Jackobs, W. C. Jacob, R. W. Jugenheimer, L. T. Kurtz, A. L. Lang, S. W. Melsted, R. T. Odell, M. M. Rhoades, O. H. Sears, E. H. Tyner.

Associate Professors: A. W. Burger, H. H. Hadley, R. H. Hageman, J. B. Hanson, C. N. Hittle, A. Klute, E. R. Leng, F. W. Slife.

Assistant Professors: D. E. Alexander, A. H. Beavers, C. M. Brown, R. W. Howell, H. A. Lund, E. B. Patterson, J. W. Pendleton, D. B. Peters, R. D. Seif, F. J. Stevenson, R. O. Weibel, J. T. Woolley.

COURSES FOR GRADUATES

401. **Soils Seminar.** I, II; ¼ unit. Staff.

402. **Chemical Properties of Soils: Their Relation to Soil Development and Plant Growth.** Chemical properties of soils and soil materials; their significance in soil development and in growth and nutrition of crop plants. Lectures, discussions, assigned reading, and bibliography. I; 1 unit. Prerequisite: Agronomy 201 and Chemistry 101, 105, and 122, or equivalent. Melsted.

403. **Genesis, Morphology, and Classification of Soils.** Historical review of work in soil genesis; genetic factors of soil formation; soil-forming processes and reactions; classification and nomenclature of soils; properties and distribution of the major soil groups of the world. Assigned reading. I; ¾ unit. Prerequisite: Agronomy 301 or consent of instructor.

405. **Colloidal Chemistry of Soils.** Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. II; 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Gieseking.

411. **Soil Physics.** The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned reading. I; 1 unit. Prerequisite: Chemistry 240 or equivalent. Klute.

412. **Soil Organic Matter.** Basic considerations in organic matter transformation; the carbon and nitrogen cycles; microbiology of organic matter synthesis; chemical nature of soil organic matter. Lectures, discussions, and assigned reading. II; 1 unit. Prerequisite: Bacteriology 104; Chemistry 132. Stevenson.

421. **Crops and Plant Breeding Seminar.** I, II; ¼ unit. Staff.

422. **Pasture, Range, and Soil Conservation Research.** Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. II; 1 unit. Prerequisite: Agronomy 121 and 321 or 322. Jackobs.

423. **Theory and Analysis of Plant Breeding Problems.** Genetics of crop plants; problems in selection and hybridization. II; 1 unit. Leng.

424. **Mineral Nutrition of Plants.** Same as Botany 424 and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients

by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. II; 1 unit. Prerequisite: Botany 130 or consent of instructor. HAGEMAN.

425. **Development of Crop Plants in Relation to Production and Breeding.** Theories of morphology and morphogenesis; principles of development and differentiation; morphogenesis of crop plants; plant development in relation to crop production and breeding. Special emphasis on cereals and grasses. Lectures, demonstrations, and assigned reading. II; 1 unit. Prerequisite: Agronomy 121; Botany 100. BONNETT.

440. **Design and Analysis of Biological Experiments, I.** Same as Animal Science 440, Dairy Science 440, Horticulture 440, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. JACOB.

441. **Design and Analysis of Biological Experiments, II.** Same as Animal Science 441, Dairy Science 441, Horticulture 441, and Veterinary Medical Science 441. A continuation of Agronomy 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Agronomy 440 or equivalent. JACOB.

499. **Thesis Research.** I, II; 0 to 4 units.
(a) **Soils.** BEAVERS, BRAY, GIESEKING, KLUTE, KURTZ, LANG, MELSTED, ODELL, PETERS, RUSSELL, SEARS, STEVENSON, TYNER, WOOLLEY.
(b) **Crops.** ALEXANDER, BONNETT, BROWN, BURGER, EARLEY, HADLEY, HAGEMAN, HANSON, HITTLE, HOWELL, JACKOBS, JACOB, JUGENHEIMER, LENG, LUND, PATTERSON, PENDLETON, RHOADES, SEIF, SLIFE, WEIBEL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Special Problems.** Individual problems in crops or soils. Graduate students majoring in agronomy do not receive graduate credit. I, II; ½ to 2 units. Prerequisite: Consent of instructor.

301. **Soil Survey, with Emphasis on Illinois Soils.** Properties and methods used in distinguishing soils; characteristics and distribution of different soils in Illinois and the cause of these soil differences; the influence of differences in Illinois soils upon their proper use and management. Laboratory work includes instruction in the use of soil maps, training in mapping soils, and field trips to examine representative Illinois soils. Field trips; estimated expense, $15.00. II; ½ unit. Prerequisite: Agronomy 201. ODELL.

302. **Role of Microorganisms in Soil Fertility.** Microorganisms of the soil in relation to fertility; nitrogen fixation, assimilation, and preservation. I; ½ unit. Prerequisite: Agronomy 201. SEARS.

305. **Laboratory in Soil Physics.** Introductory and advanced laboratory experiments illustrating principles and methods of physical studies of soils. The work is graded according to the previous training of the student. I; ½ unit. Prerequisite: Agronomy 201 or equivalent; consent of instructor. KLUTE.

306. **Fertilizers and Their Soil Reactions.** Fertilizer sources and materials; chemical forms of elements in the soil, reactions of fertilizers in soils, determination of fertilizer needs, soil test methods, fertilizer application. I; ½ unit. Prerequisite: Agronomy 201. BRAY.

307. **Principles of Soil Conservation.** National and local implications of soil con-

servation and its relation to farming systems, land management, climate, soil character and farming operations. II; ½ unit. Prerequisite: Agronomy 121 and 201.

308. **Plant Composition and Chemurgy.** Supply, chemical composition, and utilization of the principal sugar, starch, cellulose, oil, and protein crops of the world; the effect of nutritional, environmental, and genetic factors on chemical composition of these crop plants. II; ½ unit. Prerequisite: Chemistry 132 or equivalent. EARLEY.

311. **Physical Edaphology.** The underlying principles of the influence of physical properties of soils on plant growth; the application of these principles to practical problems of tillage, drainage, conservation, and plant nutrition. II; ½ unit. Prerequisite: Agronomy 201. RUSSELL.

312. **Farm Appraisals.** Same as Agricultural Economics 312. Valuation of farm real estate; soils, crops, management, buildings, drainage, land titles, prices, and taxes in relation to value. Local field trips; estimated expense, $7.00. II; 1 unit. Prerequisite: Agronomy 201 and Agricultural Economics 220, or equivalent. STEWART and others.

321. **Crop Ecology.** The environmental requirements of crop plants and their physiological bases; how well the environment provides for these requirements, particularly in the United States; the distribution and yield of specific crops as a function of environment. I; ½ unit. Prerequisite: Agronomy 121. HANSON.

322. **Forage Crops and Pastures.** Roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. Lectures and discussions. II; ½ unit. Prerequisite: Agronomy 121. JACKOBS.

323. **Improvement of Farm Crops by Breeding.** Heredity and variation in crop plants; effects of self-fertilization and cross-fertilization; principles and results of selection and hybridization in crop improvement. I; ½ unit. Prerequisite: Agronomy 110 or equivalent; Agronomy 121. BONNETT.

325. **Corn Breeding.** Principles and procedures involved in developing, testing, and production of inbred lines and hybrids; production and processing of hybrid seed corn; genetics of corn. II; ½ unit. Prerequisite: Agronomy 110. JUGENHEIMER.

326. **Weeds and Their Control.** Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. Field trip; estimated expense, $5.00. I; ½ unit. Prerequisite: Agronomy 121. SLIFE.

327. **Forage Crop Breeding.** Principles and methods of plant breeding as related to forage crops: sources of hereditary variation, identification of desirable types, methods of evaluating breeding materials, and the utilization of desirable variations are discussed; cytological, genetical, and breeding investigations of the more important forage species and the development of improved varieties are considered. I; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Agronomy 110 or equivalent; Agronomy 323 or consent of instructor. HITTLE.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Mathematics 365. A study of computing methods for efficient utilization of high speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accomplished. I; ¾ unit. Prerequisite: A 300-level course in statistics or statistical methods, or consent of instructor. JACOB.

377. Diseases of Field Crops. Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Plant Pathology 317 or consent of instructor. BEVER.

ANIMAL SCIENCE

(Including Animal Nutrition)

The Department of Animal Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Animal Science and in Animal Nutrition.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in animal science may be obtained from the head of the department, 328 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: O. B. Ross (Head of Department), L. E. CARD (assigned to India as Field Staff Coordinator), R. M. FORBES, U. S. GARRIGUS, B. C. JOHNSON, J. KASTELIC, A. V. NALBANDOV, A. L. NEUMANN, H. W. NORTON, H. M. SCOTT, S. W. TERRILL, R. J. WEBB.
Associate Professors: D. E. BECKER, E. L. LASLEY, J. M. LEWIS, G. WOLF.
Assistant Professors: B. C. BREIDENSTEIN, H. H. DRAPER, E. E. HATFIELD, A. H. JENSEN, S. P. MISTRY.

Animal Science

The Department of Animal Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy with opportunities for specialization in the fields of animal genetics, animal nutrition, meats, animal physiology, and animal production and management, including poultry.

The minimum grade-point average for admission to graduate study in animal science is 3.5.

A student who wishes to register for a minor in animal science with specialization in animal production and management for either the master's or the doctor's degree must offer at least fifteen college credits in the field, including the principles of feeding, the principles of genetics, and courses in livestock production and management, and he must have had an introductory course in organic chemistry. For a major in animal production and management, a student must offer an additional five hours of credit in animal science or husbandry or in courses related to his major field of specialization. To qualify for graduate study in the field of meats, a student must offer credit in Animal Science 104, 204, and 205 or their equivalents. Besides these general requirements, a student must have had, or be prepared to take, the special training necessary for effective graduate study in the field of his chosen specialized area of study.

Introductory courses in physiology, zoology, quantitative analysis, and in mathematics prerequisite to or including statistics, are desirable preparation for graduate work in any of the specialized areas of animal science. A reading knowledge of French and German, if acquired prior to registration in the Graduate College, obviates the necessity of devoting time to these subjects while also carrying course work in the student's special field of interest. More de-

tailed information for students interested in specializing in animal nutrition follows.

COURSES FOR GRADUATES

400. **Seminar.** A review of current literature in the science of animal production. I, II; ¼ unit. Prerequisite: Consent of instructor. STAFF.

401. **Principles of Beef Production.** A critical study of the objectives, design, and results of beef cattle experiments. I; 1 unit. Prerequisite: Consent of instructor. NEUMANN.

402. **Principles of Sheep and Wool Production.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. II; ½ unit. Prerequisite: Consent of instructor. GARRIGUS.

403. **Principles of Swine Production.** A critical study and interpretation of experiments in swine feeding, breeding, and management. Intended to aid in preparing students for positions in colleges, experiment stations, and related fields. II; ½ unit. Prerequisite: Consent of instructor. TERRILL.

404. **Principles of Poultry Production.** A discussion of research methods and findings in the field of poultry science, with some consideration of current industry problems. I; ½ unit. Prerequisite: Consent of instructor. SCOTT.

405. **Advanced Animal Genetics.** Genetic theory, analysis of animal breeding problems, genetic results of selection and different systems of breeding. I; 1 unit. Prerequisite: Animal Science 305 or equivalent. LASLEY.

406. **Physiology of Reproduction.** Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. II; 1 unit. NALBANDOV.

407. **Laboratory Methods in Animal Genetics.** I, II; ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. LASLEY.

408. **Laboratory Methods in Physiology of Reproduction.** I, II; ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NALBANDOV.

410. **Research Methods in Animal Science.** Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. I, II; ¼ to 1 unit. Prerequisite: Consent of instructor. BREIDENSTEIN, GARRIGUS, NEUMANN, SCOTT, TERRILL, and others.

411. **Population Genetics and Animal Breeding.** Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. II; 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy 440, Dairy Science 440, Horticulture 440, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simple designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. JACOB.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy 441, Dairy Science 441, Horticulture 441, and Veterinary Medical Science 441. A continuation of Animal Science 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Animal Science 440 or equivalent. JACOB.

499. **Thesis Research.** I, II; ½ to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Beef Production.** The principles of feeding and management of beef cattle; financial aspects of beef production. Lectures, demonstrations, and discussions. I, II; ¾ unit. Prerequisite: Animal Science 102. NEUMANN.

302. **Sheep Production.** The sheep and wool industries; principles and practices of various phases of production. II; ¾ unit. Prerequisite: Animal Science 102. GARRIGUS.

303. **Pork Production.** The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. I, II; ¾ unit. Prerequisite: Animal Science 102. BECKER, JENSEN, TERRILL.

304. **Poultry Management.** Poultry science and practice with special reference to the place of the poultry enterprise on Illinois farms. Veterinary students are required to take the laboratory. All others may register with or without the laboratory. II; ¾ unit. Prerequisite: Animal Science 102. SCOTT, BRAY.

305. **Genetics and Animal Improvement.** Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement. II; ¾ unit. Prerequisite: Animal Science 110 or equivalent. LASLEY, TOUCHBERRY.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. I; ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. VANDEMARK.

332. **Livestock Marketing.** Same as Agricultural Economics 332 and Marketing 332. Problems and practices in marketing livestock. Field trip; estimated expense, $7.00. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. BROADBENT.

Animal Nutrition

The Division of Animal Nutrition offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy with a major in animal nutrition. The areas of study include the nutritional requirements of domestic and laboratory animals and man, nutritive evaluation of foods and feeds, and the function and metabolism of the nutrients required by animal organisms.

The minimum grade-point average for admission to graduate study in animal nutrition is 3.5.

Candidates for a major in this field are required to have the specific prerequisite training equivalent to one five-hour course each in analytical and organic chemistry. In addition, it is highly recommended that students planning major work in animal nutrition have adequate preparation in mathematics and physical chemistry.

COURSES FOR GRADUATES

402. **Proteins and Amino Acids in Nutrition.** Methods of nutritional evaluation of proteins; nutritional requirements for individual amino acids; metabolism of the amino acids and of proteins in various species. I; ½ unit. Prerequisite: Chemistry 350 and 355. JOHNSON.

403. **Laboratory Methods in Protein and Energy Nutrition.** Techniques in protein evaluation and energy metabolism studies in nutrition investigations. I; 1 unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. FORBES.

404. **Carbohydrates, Lipids, and Energy in Animal Nutrition.** Basic principles of energy metabolism and their application to animal nutrition; caloric and non-caloric roles of carbohydrates and lipids in nutrition; influence of the rumen on energy utilization. II; ½ unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. FORBES.

405. **Animal Nutrition Seminar.** Discussions of original literature pertinent to animal nutrition. I, II; ¼ unit. Prerequisite: Consent of instructor. STAFF.

406. **Mineral Elements in Nutrition.** Nutritional requirements for individual mineral elements; physiological function; metabolism in animals; conditions contributing to mineral deficiency diseases in animals. I; ½ unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. KASTELIC.

407. **Vitamins in Nutrition.** Naturally occurring and synthetic forms of the vitamins and their biological activity for laboratory and domestic animals; clinical tests for vitamin deficiencies; metabolic products formed by different animals; functional forms of the vitamins and reactions in which they are involved; antimetabolites used in experimental nutrition. II; ½ unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. DRAPER.

496. **The Use of Carbon-14 in Labelling Techniques.** Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. II; 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. NYSTROM, WOLF.

499. **Thesis Research.** I, II; 0 to 4 units. DRAPER, FORBES, JOHNSON, KASTELIC, MISTRY, WOLF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Animal Nutrition.** An introduction to the principles and practical applications of the science of animal nutrition. Required for an undergraduate major in animal science. I; ¾ unit. Prerequisite: Animal Science 102; Chemistry 132 or 133. DRAPER.

351. **Principles of Animal Nutrition.** Studies of nutrient requirements of animals; function and utilization of nutrients; evaluation of nutritional adequacy and status; nutritional deficiency diseases; feeding and dietary standards. II; ¾ unit. Prerequisite: Chemistry 350 and 355, or Chemistry 354. KASTELIC.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the degrees of Master of Architecture and Master of Science in Architectural Engineering. Fields of specialization are architectural design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles); advanced structural theory and design; materials and methods of construction; history of architecture.

Students are expected to follow one of the recommended area programs unless approval is obtained from the chairman of the department for a special program.

The prerequisite for graduate study in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. The minimum grade-point average for admission to graduate study in architecture is 3.5. All applications for admission should be accompanied by samples of the applicant's work in structures and design.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in architecture may be obtained from the chairman of the department, 104 Architecture Building.

GRADUATE TEACHING FACULTY

Professors: A. K. Laing (Chairman of Department), W. L. Creese, G. S. Keith, D. B. Lindsay, E. Love, R. J. Smith, E. F. Toth, C. K. Wang, A. R. Williams.

Associate Professors: G. T. Clayton, E. A. Connally, P. H. Coy, H. L. Hornbeak, R. P. Link.

COURSES FOR GRADUATES

417. **The Development of Contemporary Architectural Thought.** An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, van der Rohe, Viollet-le-Duc, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, Serlio, and Vitruvius. I, II; ½ unit. Prerequisite: Consent of instructor. Laing.

431. **Architectural Procedures.** A study of architect-client relationships, budgetary factors, program development, idea conception, techniques of idea development and presentation, and the use of design check lists. I; ½ unit. Prerequisite: Consent of instructor. Williams and others.

435. **Advanced Architectural Design.** Advanced study of space relationships, building groups, and the integration of structural, mechanical, and aesthetic elements in architecture. I, II; 2 units. Prerequisite: The degree in architecture (general option) offered by the University of Illinois, or equivalent. Williams.

452. **Advanced Theory of Structures.** Slope-deflection and moment-distribution methods applied to gable frames and members with variable cross-section; the column-analogy method; fixed arches; secondary stresses; composite structures; complex structures. I, II; 1 unit. Prerequisite: Civil Engineering 461 or consent of instructor. Wang.

454. **Advanced Structural Design in Reinforced Concrete.** Critical review of the methods and specifications involved in the design for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way, and flat-slab floor construction; columns and footings; rigid frames and fixed arches; torsion; plastic theory of design; continuity in building design; introduction to prestressed concrete. I, II; 1 unit. Prerequisite: Architecture 358 or consent of instructor. Wang.

481. **Advanced Architectural Construction.** A study of traditional and contemporary building construction techniques; cost, maintenance, and depreciation factors in the building industry. May be taken concurrently with Architecture 491. I, II; ½ unit. Prerequisite: Consent of instructor. Clayton.

491. **Special Problems in Architectural Construction.** Individual direction in the investigation of selected topics in building construction. I, II; ½ to 2 units. Prerequisite: Credit or registration in Architecture 481. Clayton.

493. **Special Problems in Structural Theory and Design.** I, II; ½ to 2 units. Prerequisite: Credit or registration in Architecture 452. Wang.

494. **Special Problems in Architectural Design.** Individual or group investigation of building types, aesthetic problems, and other aspects of architecture. I, II; ½ to 2 units. Prerequisite: Architecture 435. Williams.

496. **Special Problems in History of Architecture.** Individual investigation of the

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work of particular architects, specific buildings, or the architecture of periods or regions; comparative studies; aesthetic problems. I, II; ½ to 2 units. Prerequisite: Architecture 417 or consent of instructor. CONNALLY, CREESE, LAING.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Architectural Design.** Advanced problems in modern buildings and building groups with complex requirements. I, II; 2 units. Prerequisite: Architecture 236. STAFF.

338. **Architectural Design.** Terminal project (individual research and comprehensive architectural development). I, II; 2 units. Prerequisite: Architecture 337. STAFF.

339. **Urban Housing.** A study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. II; ½ unit. Prerequisite: Consent of instructor. JONES.

347. **Theory of Structures.** Advanced problems in the analysis of statically determinate structures, and general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. I, II; 1½ units. Prerequisite: Credit or registration in Architecture 247 and Theoretical and Applied Mechanics 211. HORNBEAK.

348. **Advanced Structures.** Advanced topics on design of structural members and connection; analysis and design of continuous structures, rigid frames, and tall buildings. I, II; 1½ units. Prerequisite: Architecture 347; registration in Architecture 358. COY.

358. **Reinforced Concrete Design.** Reinforced concrete building design. I, II; 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348. WANG.

ART

The Department of Art offers graduate work leading to the degrees of Master of Fine Arts (painting and graphics, and design) and Master of Arts (art education and art history). The prerequisite for graduate work leading to these degrees is the Bachelor of Fine Arts degree as established at this University with a concentration in the field to be pursued in graduate study, or its equivalent. Student applying for admission must have a grade-point average of 3.5.

Admission to the Graduate College does not make the student a candidate for an advanced degree in the department until he has been accepted as such by the departmental graduate committee. Upon application to the Graduate College information on departmental procedures and requirements should be obtained by writing to the head of the Department of Art. Prospective students expecting to do graduate work leading to the Master of Fine Arts degree must submit original examples of their work to the departmental graduate committee in advance of registration. Students expecting to pursue study leading to the Master of Art degree in art education must have or be eligible for a teaching certificate in their field. In order to determine eligibility for graduate study, prospective students must submit, for examination, a transcript of their undergraduate credits to the head of the department. In the event that a prospective candidate for any degree in the department is found to be deficient in any professional phase of undergraduate training, the committee will require the student to take such undergraduate courses as will remove the deficiency.

Not later than mid-point in the student's proposed program, the candidate

is given a qualifying examination in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The committee may extend the residence requirement (or increase the total unit requirements) at this time or any other time, if this seems warranted. The student is recommended for the degree after a final review or examination.

The thesis required for the Master of Fine Arts degree is an original work of creative art, accompanied by a written report, while the thesis for the Master of Arts degree with a major in art history is a written document. The thesis remains the property of the University, as do such other works designated by the departmental graduate committee.

Degree of Master of Fine Arts with Design Major. To qualify for the degree of Master of Fine Arts, with a major in design, each student is required to complete satisfactorily all of the following courses to the minimum of twelve units: Art 491, one to three units; Art 493, one unit; Art 467 or 477, four to six units; art history (two courses elected from the group Art 311 through 318), one and one-half units; art electives (Art 323, 333, 341, 351, 355, 371, 372, 494, and art history), two or three units. A thesis is required.

Degree of Master of Fine Arts with Painting and Graphics Major. To qualify for the degree of Master of Fine Arts, with a major in painting and graphics, each student is required to complete satisfactorily all of the following courses to the minimum of twelve units: Art 341, one-half unit (substitution of credit in other courses may be made for this subject by permission of the departmental graduate committee); Art 491, one to three units; Art 493, one unit; Art 495, two to five units; Art 497, two to five units; art history (two courses elected from the group Art 311 through 318), one and one-half units; art electives (Art 323, 351, 371, 372, 494, and art history), one to two units. A thesis is required.

Degree of Master of Arts with Art Education Major. To qualify for the degree of Master of Arts, with a major in art education, each student is required to complete satisfactorily all of the following courses to the minimum of eight units: Art 493, one unit; art history (one course elected from the group Art 311 through 318), three-fourths unit; art electives, two and one-fourth units; Education 311, one-half unit; Education 312, one-half unit; Education 456, one unit; two of the following: Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required.

Degree of Master of Arts with Art History Major. To qualify for the degree of Master of Arts, with a major in art history, each student is required to complete satisfactorily all of the following courses to the minimum of eight units: Art 341, one-half unit; Art 491, one to three units; Art 493, one unit; Art 494, one unit; art history (elected from the group Art 311 through 320), one and one-half to three units; electives, one or two units. A thesis is required.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in art may be obtained from the head of the department, 115 Architecture Building.

GRADUATE TEACHING FACULTY

Professors: J. R. Shipley (Head of Department), C. A. Dietemann, C. V. Donovan, W. F. Doolittle, J. D. Hogan, J. W. Kennedy, F. J. Roos, E. C. Rae, H. A. Schultz, A. S. Weller.
Associate Professors: C. W. Briggs, L. R. Chesney, M. B. Martin, N. Ziroli.
Assistant Professor: R. A. Von Neumann.

COURSES FOR GRADUATES

37. Advertising Design Laboratory. Individually directed research in the studio

with concentration in advertising design. I, II; 1 to 2 units. Prerequisite: Bachelor of Fine Arts degree in advertising design or equivalent. DONOVAN.

477. **Industrial Design Laboratory.** Individually directed research in the drafting room or workshop with concentration in industrial design. I, II; 1 to 2 units. Prerequisite: Bachelor of Fine Arts degree in industrial design or equivalent. SHIPLEY.

491. **Special Problems.** Individual direction in research and in creative activity; thesis. I, II; 1 to 2 units. STAFF.

493. **Seminar.** Introduction to methods of research and criticism. I; 1 unit. ROOS, WELLER.

494. **Studies in Art History and Criticism.** Individual study of special periods of art history; intensive reading of selected critical works; the writing of art criticism. I, II; 1 to 2 units. RAE, ROOS, WELLER.

495. **Painting Laboratory.** Professional and experimental painting with emphasis on the development of maturity of style and personal expression. I, II; 1 to 2 units. STAFF.

497. **Graphics Workshop.** Intaglio printing, including etching, engraving, and aquatint. I, II; 1 to 2 units. CHESNEY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Classical Art.** Architecture, painting, sculpture, and minor arts of Greece and other ancient civilizations of the Mediterranean area. I or II; ¾ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. RAE.

312. **Medieval Art.** Architecture, painting, sculpture, and minor arts of the Middle Ages in Europe. I or II; ¾ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. RAE.

313. **Italian Renaissance Art.** Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. I or II; ¾ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. MILLER, WELLER.

314. **Northern Renaissance Art.** Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. I or II; ¾ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. MILLER, WELLER.

315. **Art of the Nineteenth Century.** Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. I or II; ¾ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. ROOS.

316. **Art of the Twentieth Century.** Architecture, painting, sculpture, and minor arts of the twentieth century in France, Germany, Spain, and England. I or II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. ROOS.

317. **American Art.** Architecture, painting, sculpture, and minor arts of the colonies and the United States. I or II; ¾ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. ROOS.

318. **Latin-American Art.** A study of the more important phases and periods of the visual arts of Latin America. II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. RAE.

319. **Italian Art of the Seventeenth and Eighteenth Centuries.** An examination of the arts of painting, sculpture, and architecture of the seventeenth and eighteenth centuries in Italy in terms of major figures and dominant stylistic tendencies. I; ¾ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. MILLER.

320. **Northern European Art of the Seventeenth and Eighteenth Centuries.** An examination of major developments in painting, sculpture, and architecture in the Low Countries, France, Spain, Germany, and England during the seventeenth and eighteenth centuries. II; ¾ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. MILLER.

323. **Drawing.** Advanced drawing in several media. I, II; ½ to 1 unit. Prerequisite: Art 126 or equivalent. BRIGGS.

333. **Painting.** Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts degree in painting and graphics. I, II; ½ to 1 unit. Prerequisite: Art 142 or equivalent. STAFF.

341. **Painting Materials and Techniques.** Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. II; ½ unit. Prerequisite: Art 142 or graduate standing in art. KENNEDY.

351. **Advanced Sculpture Techniques.** Advanced work in various sculptural media. I, II; ½ to 1 unit. Prerequisite: Art 252 or equivalent. MARTIN.

355. **Graphic Media.** Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts degree in painting. I, II; ½ to 1 unit. Prerequisite: Art 256 or equivalent. CHESNEY.

371. **Silversmithing, I.** Advanced course in design and execution of hollow ware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. I, II; ½ unit. Prerequisite: Art 172 or equivalent. VON NEUMANN.

72. **Silversmithing, II.** Advanced course in design and execution of flatware and hollow ware, dealing primarily with forging and seaming methods, engraving, and toolmaking. I, II; ½ unit. Prerequisite: Art 371. VON NEUMANN.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the degrees f Master of Science and of Doctor of Philosophy in Astronomy (including radio stronomy). The admission requirements for graduate study in astronomy are the eneral regulations governing admission of all graduate students. Applicants must ave a grade-point average of at least 3.5. In addition, the entrance requirements re as follows: (1) an undergraduate major in astronomy, mathematics, or physics, r a Bachelor of Science degree in either electrical engineering or engineering hysics; and (2) a one-year course in descriptive astronomy, e.g., Astronomy 201 nd 202.

The eight units for the Master of Science degree may be obtained in three ays, listed as (1), (2), and (3) below. Alternative (3) is intended for students ishing to specialize in radio astronomy.

(1) All eight units may be taken in astronomy; at least three units must be the 400 level.

(2) Two units may be selected from Mathematics 341, 342, 343, 345, 455, 56, or 459; two units may be taken in Physics 321, 322, 341, 342, 371, 381, 400, 22, or 481; the remaining units must be taken in astronomy. At least three units

must be at the 400 level, and at least two of these three units must be taken in astronomy.

(3) Five units may be secured by taking Physics 341, 342, Electrical Engineering 420, 421, and Astronomy 357. The remaining three units must be taken in astronomy; only one of these units need be at the 400 level.

Details regarding the degree of Doctor of Philosophy may be obtained by writing to the head of the department, University of Illinois Observatory, Urbana, Illinois. By arrangement with the University of Chicago, students for this degree may obtain instruction in advanced observational methods in optical astronomy at the Yerkes Observatory, Williams Bay, Wisconsin. Credit so obtained may be transferred to the University of Illinois.

For information regarding applied mathematics, see page 196.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in astronomy may be obtained from the head of the department, Observatory.

GRADUATE TEACHING FACULTY

Professor: G. C. McVittie (Head of Department).
Associate Professor: G. W. Swenson.
Assistant Professors: I. R. King, S. P. Wyatt.

COURSES FOR GRADUATES

404. **Theory of Stellar Structure.** Mathematical theory of the internal equilibrium of a gaseous star under the action of gravity, gas pressure, and radiation pressure; types of stars; source of stellar energy. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

415. **Experimental Methods in Radio Astronomy.** Design and construction of instruments for radio astronomy; techniques of observation of celestial radio sources; interpretation of data. I or II; 1 unit. Reregistration permitted. Prerequisite: Consent of instructor. Swenson.

421. **Dynamics of Stellar Systems.** The observational data; regularities in stellar motions; kinematics of a rotating galaxy; dynamics and mass distributions; stellar encounters; dynamics of star clusters; statistical mechanics of stellar systems; dynamics of the interstellar medium; spiral structure; evolution of galaxies. I or II; 1 unit. Prerequisite: Consent of instructor. King.

424. **Relativity and Cosmology.** Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. McVittie.

464. **Dynamics of the Earth's Atmosphere.** Same as Mathematics 464 and Physics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

491. **Seminar in Special Topics.** I or II; 1 to 4 units. Prerequisite: Consent of instructor. McVittie.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introductory Astrophysics.** Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interior

special types of stars, interstellar matter. I or II; 1 unit. Prerequisite: Physics 107 and 108. King.

306. **Foundations of Mechanics and Gravitational Theory.** Same as Aeronautical Engineering 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to earth, precession of earth's axis, etc. I or II; 1 unit. Prerequisite: Mathematics 142 or 143. McVittie.

307. **Celestial Mechanics.** Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. I or II; 1 unit. Prerequisite: Astronomy 306 or Physics 322. McVittie.

314. **Observational Astronomy.** Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. I or II; 1 unit. Prerequisite: Astronomy 201 and 202; Mathematics 142 or 143. Wyatt.

321. **Galactic Structure.** Observational data on the distribution of stars in space; stellar statistics; stars in solar neighborhood; space-density analyses; galactic rotation; stellar populations and their distributions; the form and content of galaxies. I or II; 1 unit. Prerequisite: Astronomy 202; Astronomy 306 or Physics 322. Wyatt.

357. **Radio Astronomy.** Same as Electrical Engineering 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. I or II; 1 unit. Prerequisite: Physics 107 and 108. Swenson, Wyatt.

BACTERIOLOGY

The Department of Bacteriology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. Students electing bacteriology as a major for an advanced degree must have had, in addition to formal training in general bacteriology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these course requirements may apply for admission if they have a grade-point average of at least 4.0.

Candidates for the degree of Master of Science must pass a general written comprehensive examination toward the close of the second semester of residence.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in bacteriology may be obtained from the head of the department, 362 Noyes Laboratory.

GRADUATE TEACHING FACULTY

Professors: H. O. Halvorson (Head of Department), F. M. Clark, S. E. Luria, S. Spiegelman, G. I. Wallace.
Associate Professors: R. D. DeMoss, R. S. Wolfe.
Assistant Professor: J. T. Wachsman.

COURSES FOR GRADUATES

304. **Quantitative Analysis of Bacteriological Procedures.** Quantitative analysis of

counting methods, antibiotic assay methods, vitamin assay methods, analysis of growth and death curves, methods of measuring mutation frequency, and quantitative aspects of epidemiology. I; ¾ unit. Prerequisite: Bacteriology 300 and 306. HALVORSON, SPIEGELMAN.

405. **Microbiological Genetics.** Study of the phenomenon of heredity in microorganisms with particular reference to recent developments in the field. Examples from protozoa, yeasts, molds, bacteria, and viruses are considered. Emphasis is placed on critical examination and evaluation of methods. Implications of results for fundamental aspects of gene functions are considered. I; ¾ unit. Prerequisite: Genetics (Botany 322 or Zoology 351) Bacteriology 404; mathematics through calculus, or consent of instructor SPIEGELMAN.

420. **Chemistry of Microbic Processes.** The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimilation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. II; ¾ unit. Prerequisite: Bacteriology 300 and Chemistry 234 and 350, or equivalent; consent of instructor DEMOSS.

425. **Bacterial Metabolism Laboratory.** Designed to give a working knowledge of the methods currently employed in the study of the chemical aspects of microorganisms. Experiments include the analysis of fermentation mixtures the metabolic properties of microorganisms and the enzymes involved a illustrated with resting cells, cell preparations, and cell-free enzymes. Th application of manometric, colorimetric, and isotopic methods to the stud of microorganisms and the purification of microbic enzymes are includec II; ¾ unit. Prerequisite: Credit or registration in Bacteriology 420; consen of instructor. DEMOSS.

451. **Experimental Virology.** Experiments to illustrate the main properties c viruses. II; ¾ unit. Prerequisite: Credit or registration in Bacteriology 351 consent of instructor. LURIA.

490. **Individual Problems.** I, II; ½ to 4 units. STAFF.

495. **Seminar.** Required of all graduate students whose major is bacteriology I, II; 0 to ¼ unit. Prerequisite: Ten hours of bacteriology; consent c instructor. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Microbiology.** Emphasis is placed on the fundamental concepts ar techniques of microbiology; isolation, cultivation, and observation of bacteri The morphology, physiology, and nutrition of microorganisms; their role i nature, and infection and immunity are considered. I, II; 1 unit. Prerequ site: A college course in general botany or zoology; chemistry throug organic. WACHSMAN, WOLFE.

306. **Principles of Experimental Bacteriology.** A study of the experimental bas of bacterial physiology, cytochemistry, and variation; the conditions whic influence metabolism, growth, and death; the properties of the bacterial ce and the bacterial culture. Laboratory experiments are designed to illustra the principles of experimentation as applied to microorganisms. I; 1 uni Prerequisite: Bacteriology 300; Chemistry 124 and 234, or equivalen DEMOSS, LURIA.

308. **Food and Industrial Microbiology.** The relationship of microorganisms to food manufacture and preservation, and to industrial fermentation and processing. The laboratory considers the properties of the bacteria, yeasts, molds, and actinomyces of importance to industrial processes and methods of control. Lecture and laboratory. I; 1 unit. Prerequisite: Bacteriology 104 or 300. CLARK, HALVORSON.

309. **Nutrition and Cultivation of Microorganisms.** Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, cultivation of bacteria, and microbiological assays. II; 1 unit. Prerequisite: Bacteriology 104 or 300; chemistry through quantitative analysis and organic. WOLFE.

326. **Pathogenic Bacteriology.** A study of the pathogenic bacteria: classification, morphology, cultural requirements, and reactions; toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lecture and laboratory. I; 1 unit. Prerequisite: Bacteriology 104 or 300. WALLACE.

327. **Immunology and Serology.** A survey of the field of immunology; prevention of disease, diagnosis, and preparation and use of biologicals in the treatment of disease. Lecture and laboratory. II; 1 unit. Prerequisite: Bacteriology 104 or 300. WALLACE.

351. **Viruses.** The study of filtrable viruses as a branch of microbiology: statistical, physical, and chemical properties of virus particles; analysis of host-virus interaction; origin and natural relations of viruses. II; ¾ unit. Prerequisite: Bacteriology 300 or equivalent. LURIA.

BIOLOGICAL SCIENCES

Through the Division of the Biological Sciences (including bacteriology, botany, entomology, physiology, psychology, zoology) it is possible to arrange a program leading to the degree of Master of Science in the Biological Sciences. Students seeking admission to this division must have a grade-point average of at east 3.5.

While the main emphasis is on botany and zoology, the candidate must have t least one unit in each of the following subjects: bacteriology, botany, entomology, hysiology, and zoology. One unit in psychology (other than educational psychol- gy) is strongly recommended. In planning his course of study the candidate hould give less emphasis to subjects in which he has already had considerable raining. At least one unit must be taken in courses of graduate grade (courses umbered 400 and above). A thesis is not required, but at least one course should e included in which individual problems are assigned. The chairman of the ivision of Biological Sciences is Professor L. E. Chadwick, 100c Harker Hall.

Candidates for the degree of Master of Science in the Teaching of the Biogical Sciences and General Science must earn four units in biological sciences, wo units in education, and two units in electives. The two units in education ust include two of the following courses: Education 301, 302, 303, 304, one unit; nd Education 311 and 312, one unit. The courses in the biological sciences and e electives must be selected with the approval of the adviser. The electives may e in the biological sciences, in education, or, in exceptional cases, in other fields. course in biological chemistry and one in experimental psychology are strongly dvised. The adviser for candidates for this degree is Professor W. N. Stewart, 08a Natural History Building.

Students wishing to combine training for research in biology with graduate ork in physics and chemistry may be interested in the curriculum offered under ophysics (page 234).

BOTANY

The Department of Botany offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. Candidates for advanced degrees must have had at least twenty hours of undergraduate work in botany, or fifteen hours in botany and five hours in a related subject acceptable to the department. Admission to graduate work in the department is contingent upon satisfaction of admission requirements of the Graduate College which are described in the general introductory section of this catalog. Specifically, the applicant's grade-point average must be at least 3.75.

The following fields of botany are available for specialization within the department: anatomy, cytogenetics, cytotaxonomy, ecology, mycology, paleobotany, phycology, physiological genetics, physiology (including photosynthesis), plant geography, taxonomy, and virology.

Attention is called to courses offered in the Departments of Agronomy, Bacteriology, Chemistry, Entomology, Geography, Geology, Horticulture, Mathematics, Physics, Physiology, Plant Pathology, and Zoology, which are available to advanced students and offer a broad foundation for botanical work. Graduate students in botany may elect their minor subjects in one or two of these fields.

Graduate students may avail themselves of the University herbarium which contains 400,000 specimens of vascular plants, bryophytes, algae, fungi, and fossil plants. As field laboratories, the University maintains two tracts of woodland, Brownfield Woods and Trelease Woods; in addition, certain areas of Robert Allerton Park near Monticello have been designated for research and study. Several ranges of greenhouses are maintained for experimental work with living plants, and laboratories well equipped for research in plant physiology, including exceptional facilities for studies of photosynthesis, are available to students in these fields. Laboratory and greenhouse facilities for research in genetics, mycology, paleobotany, and plant virology have been expanded recently and are completely equipped. The Maize Genetics Research Laboratory maintains an extensive collection of maize genetic stocks adapted to the North Central States. the College of Agriculture and the Agricultural Experiment Station offer exceptional facilities to graduate students in plant genetics, plant pathology, and in some others of the plant sciences. The Natural History Library, with over 70,000 volumes, offers excellent library facilities, with bibliographical aids, including the Gray Herbarium Card Index of American Plants, the Index of American Botanical Literature of the Torrey Botanical Club, and the Tilden Index Algarum Universalis. The University also maintains such facilities as electron microscopes, electronic computer, betatron, ultracentrifuge, and a radiocarbon laboratory for use in tracer studies.

Degree of Master of Science. During their graduate work or as advanced undergraduates, candidates for this degree must have completed courses in the following basic fields of botany: (1) taxonomy (Botany 460 or equivalent) (2) morphology (Botany 302 and 303, or equivalent), (3) ecology or plant geography (Botany 381, or 385 or 386, or equivalent), (4) genetics (Botany 32 or equivalent), (5) physiology (Botany 130 or equivalent).

A thesis is not required of candidates for the Master of Science degree except at the option of the graduate student's major adviser. Graduate students do not receive credit in research courses toward the master's degree unless they write acceptable master's theses. The master's degree is not prerequisite to work toward the doctorate; that is, a student may engage in graduate work toward the Doctor of Philosophy degree without having obtained a master's degree.

Degree of Doctor of Philosophy. Candidates for this degree must complete the course requirements listed above before receiving the Doctor of Philosophy degree. Students who commence their graduate work at the University of Illino

ordinarily complete these requirements during their first year of graduate study. Students who enter upon graduate work toward the doctor's degree at the University of Illinois after having received the master's degree from some other university, or after having completed some graduate work at another university, are required to complete any of the above-listed courses which they may not have had. Having satisfied these basic course requirements, the candidate for the doctor's degree may elect whatever other graduate courses he desires, subject to the approval of his major professor and to the general regulations of the Graduate College concerning requirements in his major and minor fields (see the general introductory section of this catalog).

All candidates for the Doctor of Philosophy degree in botany must pass a qualifying examination in the above-listed basic fields of botany, the purpose of which is to determine whether the student is qualified to pursue further work toward the degree and to provide a basis for recommending a program of study in those areas in which he may be deficient. This examination is administered as a written examination to be taken by all doctorate candidates within one year after initiation of their studies at the University of Illinois. Qualifying examinations are given in the fall and in the spring in accordance with a schedule set by the botany faculty.

Master's and doctor's theses are due in the office of the Department of Botany ten days before they are due in the Graduate College Office. During this period theses are available for reading by faculty members who may suggest changes in them before they are delivered to the Dean of the Graduate College. Graduate theses must be prepared in accordance with "Instructions for Preparation of Theses," a publication available in the Graduate College Office.

Students desiring to obtain a master's degree preparatory to high school teaching should register in the graduate teacher-training curriculum leading to the Master of Science degree in the Teaching of the Biological Sciences and General Science (see page 59). The adviser for candidates for this degree is Professor W. N. Stewart, 308a Natural History Building.

Opportunities for biophysical research are available in the Botany Department in an interdepartmental curriculum leading to the degree of Doctor of Philosophy in Biophysics, and requiring a combined training in physics, chemistry, and biology.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in botany may be obtained from the chairman of the department, 208 Natural History Building.

GRADUATE TEACHING FACULTY

Professors: J. R. Laughnan (Chairman of Department), L. M. Black, R. Emerson, H. J. Fuller, G. N. Jones, E. I. Rabinowitch, M. M. Rhoades, D. P. Rogers, W. N. Stewart.
Associate Professors: J. F. Nance, P. C. Silva.
Assistant Professors: L. R. Heckard, D. M. Post.
Instructor: L. C. Bliss.

COURSES FOR GRADUATES

402. Physiological Genetics. The probable nature of the gene and its action as deduced from studies on chromosome chemistry, genetically controlled reactions, cytoplasmic inheritance, mutation and gene analogues, with emphasis on higher plants and fungi. II; ½ or 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Botany 322 or equivalent. Laughnan.

403. Physiology of Fungi. Same as Plant Pathology 403. The germination,

growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Organic or biochemistry; mycology, plant pathology, or microbiology. GOTTLIEB.

410. **Botanical Discussions.** Required of all graduate students in botany. I, II; 0 to ¼ unit.

411. **Discussions in Genetics and Cytogenetics.** Same as Zoology 411. I, II; ¼ unit. KITZMILLER, LAUGHNAN, LUCE, RHOADES.

413. **Discussions in Plant Physiology.** I; ¼ unit. FULLER, NANCE.

414. **Discussions in Plant Morphology and Taxonomy.** I; ¼ unit. HECKARD, JONES, POST, SILVA, STEWART.

418. **Discussions in Plant Ecology and Plant Geography.** Developments in ecology and plant geography, with emphasis on one special division. I; ¼ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. BLISS.

419. **Discussions in Photosynthesis and Related Topics.** I, II; ¼ unit. Prerequisite: Consent of instructor. EMERSON, RABINOWITCH.

420. **Cytology.** Study of nuclear and cell division, with emphasis on chromosome structure and behavior. Various aspects of cytological behavior are considered in relation to genetics and development. I; 1 unit. Prerequisite One year of botany. RHOADES.

421. **Cytogenetics.** An advanced course in which emphasis is placed on the correlation of genetic data with chromosomal aberrations. II; 1 unit. Prerequisite: Botany 420 and 322, or equivalent. RHOADES.

424. **Mineral Nutrition of Plants.** Same as Agronomy 424 and Horticulture 424 A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality o various anions and cations in the light of metabolic activity and constituenc in functional plant compounds. Major emphasis is placed on metaboli activity and function of the elements. II; 1 unit. Prerequisite: Botany 13(or consent of instructor. HAGEMAN.

426. **Palynology.** The study of pollen and other spores with emphasis on thei evolution, paleoecological significance, stratigraphic application, and method of preparation for study. I; ½ unit. Offered in 1958-1959 and in alternat years.

427. **Discussions in Mycology.** A seminar course designed for discussion of curren research activities in the morphology, taxonomy, and physiology of fung especially the nonparasitic forms. I, II; ¼ unit. Prerequisite: Consent c instructor. ROGERS.

433. **Advanced Physiology of Growth, Responses and Reproduction.** I; 1 unit Prerequisite: Botany 130 or equivalent. FULLER, HANSON.

435. **Plant Physiology: Metabolic Transformations.** II; ½ or 1 unit. Prerequisite One year of botany, including Botany 130; one year of chemistry. NANCE

436. **Principles in Plant Physiology Illustrated by Experiments with Algae.** A laboratory course limited to six students. The course includes experiment on the nutrition of algae, photosynthesis, respiration, fermentation, an enzyme processes. II; 1 unit. Prerequisite: At least one course each i biology, chemistry, and physics or physical chemistry, at college leve EMERSON.

450. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology c

algae. II; ½ or 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. SILVA.

460. **Advanced Taxonomy of Flowering Plants, I.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. I; ½ or 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Botany 160 or one year of botany or another biological science, or consent of instructor. JONES.

461. **Advanced Taxonomy of Flowering Plants, II.** The application of cytology, ecology, genetics, and morphological analyses to the study of evolution and the natural relationships of populations as exemplified by species of higher plants. II; ½ or 1 unit. Offered in 1958-1959 and in alternate years. Prerequisites: Botany 160 and 322 or equivalent. Consent of instructor. HECKARD.

471. **Advanced Mycology: Special Groups.** Special groups of fungi and their activities are considered. Different groups for concentrated study may be selected each semester depending upon the student's interest in mycology. I, II; ½ unit. Prerequisite: Consent of instructor. ROGERS.

472. **Industrial Mycology.** The characteristics, relationships, and activities of fungi of industrial importance are considered. Yeasts and mushrooms are included but major emphasis is placed on Mucorales, Aspergilli, Penicillia, and Fungi Imperfecti. I; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Consent of instructor. ROGERS.

488. **Ecology: Plant Communities.** Characteristics, types, development, and classification of communities. II; ½ or 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: One year of botany, including Botany 280 or 381. BLISS.

499. **Thesis Research.** I, II; 0 to 4 units. Work may be taken in the following fields, subject to approval of one of the staff.
(a) **Plant Morphology.** POST, ROGERS, SILVA, STEWART.
(b) **Plant Physiology.** FULLER, HANSON, NANCE.
(c) **Taxonomy of Vascular Plants and Bryophytes.** JONES.
(d) **Mycology.** ROGERS.
(e) **Plant Virology.** (Same as Plant Pathology 499.) BLACK.
(f) **Plant Ecology or Plant Geography.** BLISS.
(g) **Plant Anatomy.** POST.
(h) **Photosynthesis.** EMERSON, RABINOWITCH.
(i) **Genetics and Cytogenetics.** LAUGHNAN, RHOADES.
(j) **Paleobotany.** STEWART.
(k) **Phycology.** SILVA.
(l) **Cytotaxonomy.** HECKARD.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

00. **Individual Topics.** For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degree. I, II; ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. STAFF.

02. **Comparative Morphology: Nonvascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, and bryophytes. Students receiving credit for Botany 302 do not receive credit for Botany 304. I; ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. ROGERS, SILVA, STEWART.

303. **Comparative Morphology: Vascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative vascular plants, including psilopsids, lycopsids, sphenopsids, ferns, gymnosperms, and angiosperms. Students receiving credit for Botany 303 do not receive credit for Botany 304. II; ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. HECKARD, POST, STEWART.

304. **General Plant Morphology.** A survey of the principles of plant morphology as exemplified by the various plant groups. Designed primarily for high school and college teachers who are summer session students. Students receiving credit for Botany 304 do not receive credit for Botany 302 or 303. S; ½ or 1 unit. Offered in 1958 and in alternate years. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. STEWART.

306. **Biology for Teachers.** Same as Zoology 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. In order to make out-of-town practice teaching possible, this course does not meet during the six-week practice teaching period. II; ¼ or ½ unit. Prerequisite: Botany 100 and Zoology 101 or 104, or a year course in general biology. FULLER, MATTESON.

317. **Plant Pathology.** Same as Plant Pathology 317. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science, including Botany 100. BLACK.

322. **Genetics.** A basic treatment of the facts and fundamental principles of genetics, with special emphasis on plants. I; 1 unit. Prerequisite: One year of botany. LAUGHNAN.

325. **Paleobotany.** Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. II; ½ or 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor. STEWART.

340. **Histological Technique.** Survey of techniques used in the preparation of tissues for microscopical examination. II; ½ or 1 unit. Prerequisite: One year of botany or ten hours of zoology. POST.

345. **Plant Anatomy.** Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. I; ½ or 1 unit. Prerequisite: One year of botany. POST.

366. **Field Botany.** Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. HECKARD, JONES.

372. **General Mycology.** Structure, classification, and identification of fungi, including those of economic importance. Modification of the course is made to meet the needs of teachers and prospective teachers during the summer. II; 1 unit. Prerequisite: One year of botany, bacteriology, entomology, or zoology. ROGERS.

380. **Field and Forest Ecology.** Outdoor biology, primarily for teachers, based on prairie and forest vegetation in Illinois. One two-day and two one-day field trips are included. Students receiving credit for Botany 380 do not receive credit for Botany 381. S; 1 unit. Prerequisite: One course in botany. BLISS.

381. **Plant Ecology.** Principles of ecology, exemplified by vegetation and environments of Illinois. Students receiving credit for Botany 381 do not receive credit for Botany 380. I; ½ unit. Prerequisite: One year of botany. BLISS.

385. **Plant Geography of North America.** Vegetation regions and principal subdivisions; environments, plant cover, floras. I; ½ or 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: One year of botany. Bliss.

386. **Plant Geography of Continents Other Than North America.** Regions, vegetation-types, notable species. I; ½ or 1 unit. Prerequisite: One year of botany. Bliss.

BUSINESS

The degree of Doctor of Philosophy in Business is awarded to those who complete the subject-matter requirements listed below and the general requirements named in the forepart of this catalog. The subject-matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Students lacking adequate preparation for admission may be admitted with the consent of the adviser or committee in charge, but must remove any deficiencies during the first year of residence by taking prescribed courses without credit toward the advanced degree. Those candidates who hold a master's degree in economics or business can usually complete the requirements in two years by appropriate synchronization of courses previously taken with those offered in this program.

In lieu of the provisions on major and minor subjects on page 24, candidates for the Doctor of Philosophy degree in Business prepare themselves for examination in five fields, including management, marketing, and economic theory. At least two other fields must be selected, one of which (two units) may be outside the College of Commerce and Business Administration if approved by the adviser. For numbers and titles of courses available, see the courses listed in this catalog under Accountancy, Business Education, Economics, Finance, Management, and Marketing.

Inasmuch as the major fields for this degree cross departmental lines, administration of the work is in the hands of a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the chairman of the Committee on the Doctor of Philosophy Degree in Business, 411 David Kinley Hall.

COURSES FOR GRADUATES

99. **Thesis Research.** I, II; 0 to 4 units.

BUSINESS ADMINISTRATION

The course listed below may be taken for major credit in the Departments of Accountancy, Economics, Management, and Marketing.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

103. **Electronic Data Processing for Business.** A course in the fundamentals of business data processing. The use of modern electronic computers in the areas of accountancy, economics, management, marketing, and general

business is considered. I, II; ½ to 1 unit. Prerequisite: Economics 170; Accountancy 106 or 108. SCHLOSSER, YANCEY, and others.

BUSINESS EDUCATION

The Department of Business Education offers graduate work leading to the degree of Master of Science in Commercial Teaching. The work is part of an integrated five-year program for those preparing to become commercial teachers. The requirements of the fifth year are based on the educational background of the first four years. Students may also take advanced degree programs in education specializing in business education.

Students seeking admission in any area must have a grade-point average of 3.5. Only a limited number of the requirements listed below may be completed by extramural graduate study. Questions related to extramural courses should be referred to the appropriate graduate adviser.

Candidates for the degree of Master of Science in Commercial Teaching must earn three units in education, as described in Group 1 below; three units in commerce, consisting of two units from courses listed in Group 2 below and one unit from courses listed in Group 3 below (business education); and two units of electives. All courses must be selected with the approval of the student's adviser.

(1) Education. Three units consisting of Education 311, 312, 456, and two of the following: Education 301, 302, 303, 304.

(2) Commerce (other than business education). Two units selected from Accountancy 308, 371, 401, 427; Business Law 301; Economics 326, 328, 384, 388, 400, 414, 415, 436, 440, 441; Management 312; Marketing 315, 372, 373, 387, 401, 415, 421, 481.

(3) Commerce (business education). One unit selected from Business Education 351, 352, 353, 361, 382, 383, 491.

(4) Recommended electives. Two units selected from courses listed under (1) and (2), or not more than one unit from (3), or from courses in the following list: Education 354, 381, 390, 391, 401, 411, 413, 422, 423, 425, 428, 439, 460; Journalism 308; Rhetoric 351. These courses are suggestions only; others may be taken with the consent of the adviser.

The adviser for candidates for this degree is Professor Arnold C. Condon, 9 David Kinley Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in business education may be obtained from the head of the department, 9 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professor: A. C. CONDON (Head of Department).
Associate Professor: ELIZABETH R. MELSON.
Assistant Professors: F. L. CRANK, R. E. MASON, MILDRED E. REED.

COURSES FOR GRADUATES

499. Thesis Research. I, II; ½ to 2 units. CONDON.
Note: See also Education 456 and 459.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. Improvement of Instruction in Shorthand. A study of the history, principles and practices of shorthand instruction, including evaluation of literature

research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including Business Education 112; sixteen hours in education, including Education 242. CONDON, REED.

352. **Improvement of Instruction in Typewriting.** A study of the history, principles, and practices of typewriting instruction, including evaluation of literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including Business Education 203; sixteen hours in education, including Education 242. MELSON, REED.

353. **Improvement of Instruction in Bookkeeping.** A study of the history, principles, and practices of bookkeeping instruction, including evaluation of literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including six hours in accountancy; sixteen hours in education, including Education 242. MASON.

361. **Teaching Office Management and Machine Operations.** Designed for high school and college teachers. Selection and use of machines, course content for machine courses, and organization of instructional material. S; ½ unit. Prerequisite: Education 241, 242; sixteen hours in commerce, six of which must be in accountancy; one year of teaching experience. MELSON.

382. **Organization and Administration of Cooperative Part-Time Programs in Business Education.** Deals with background, aims, coordination techniques, and administrative policies for organizing and operating cooperative part-time programs in distributive and office occupations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce; consent of instructor. MASON.

383. **Problems in Cooperative Education.** Students apply for and secure distributive or office positions with selected cooperating business firms. While regularly employed in these supervised positions, they observe the relationships between those activities and the cooperative business education programs in the high school. These relationships are pointed up through regularly scheduled class meetings where emphasis is placed on job analysis, current trends, wage and benefit structure, personnel practices, and labor relations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce. MASON.

BUSINESS LAW

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE TEACHING FACULTY

Professors: E. R. DILLAVOU (Head of Department), P. C. ROBERTS.
Associate Professor: B. F. KIRKPATRICK.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

00. **Business Torts.** Liability of businessmen for their wrongful acts, and those of their agents arising separate and apart from their liabilities under con-

tracts; covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, inducing breach of contract. II; ¾ to 1 unit. Prerequisite: Business Law 100, 201, or 202.

301. **The Law of Security Transactions and Banking.** Significant phases of law in the fields of pledges, chattel mortgages, conditional sales, suretyship, insurance, real property, banks and banking, and bankruptcy. Under real property, real estate mortgages, landlord and tenant and mechanics liens are considered as well as the general principles of real property. I, II; ½ to 1 unit. Prerequisite: Business Law 100 or credit or registration in Business Law 202. Dillavou.

302. **Wills, Estates, and Trusts.** A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. I; ½ to 1 unit. Prerequisite: Business Law 100 or credit or registration in Business Law 202. Roberts.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers graduate work leading to the degrees of Master of Science in Ceramics, Master of Science in Ceramic Engineering, Doctor of Philosophy in Ceramics, and Doctor of Philosophy in Engineering.

The prerequisite for a major in graduate work in ceramics or ceramic engineering is proficiency in the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired, or substantial equivalents. An applicant's undergraduate grade-point average must be at least 3.5.

Candidates for the degree of Doctor of Philosophy in Ceramics must have had the equivalent of at least twenty-five semester hours of satisfactory courses in general, analytical, physical, and organic chemistry; also calculus, one year of college physics, and at least eighteen semester hours or their equivalent in acceptable ceramic courses.

Students with bachelor's degrees in chemistry, physics, or engineering may become candidates for the Master of Science or Doctor of Philosophy degree but must make up deficiencies in ceramics by taking undergraduate courses a reduced graduate credit. The student must, however, always be registered in a least one unit of graduate work.

The fields for majoring in ceramics or ceramic engineering are refractories porcelain enamels, glass, whitewares, structural clay products, and materials. Th most common minors selected by graduate students in ceramic engineering ar chemistry, physics, metallurgy, mathematics, geology, and engineering. A firs minor, however, may be taken in the Department of Ceramic Engineering.

Students majoring in chemistry, physics, engineering, and other departmen may take sole or second minors in ceramics or ceramic engineering. A secon minor requires no ceramic prerequisite.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in ceramic engineerin may be obtained from the head of the department, 204 Ceramics Building.

In addition to University fellowships, the following industrial fellowships a available to graduate students in ceramic engineering: Armco Steel Corporatic Fellowship, General Electric Company Fellowship, Hammond Lead Products Fe lowship, Lead Industries Fellowship, Edward Orton Jr. Ceramic Foundatic Fellowship, Owens-Corning Fiberglas Fellowship, Titanium Alloy Division National Lead Company Fellowship.

GRADUATE TEACHING FACULTY

Professors: A. I. Andrews (Head of Department), A. W. Allen, R. L. Cook, A. L. Friedberg, F. V. Tooley.
Associate Professor: E. D. Lynch.
Assistant Professor: R. J. Beals.

COURSES FOR GRADUATES

401. **Ceramic Chemistry.** Silica, silicates, fusions, and phase relations. I; 1 unit. Prerequisite: Courses in chemistry and physics. Andrews.

402. **Ceramics.** Chemical and physical phenomena. II; 1 to 2 units. Prerequisite: Courses in physics and chemistry. Andrews.

405. **Glass Technology.** This course, designed for ceramic engineering graduates, is required for students majoring in glass technology and may be elected by students majoring in some other branch of ceramic engineering. The course is concerned with the study of the properties of glass of importance in manufacturing and end use; emphasis is placed equally on research, control, development, and production aspects of the subject. I; 1 unit. Prerequisite: Ceramic Engineering 214 and 217, or equivalent. Tooley.

406. **Glass Technology.** This course, designed for ceramic engineering graduates, is required for students majoring in glass technology and may be elected by students majoring in some other branch of ceramic engineering. The course includes comprehensive literature surveys on selected topics and seminar type reports on classical researches in glass technology. Emphasis tends to the research point of view. II; 1 unit. Prerequisite: Ceramic Engineering 214 and 217, or equivalent. Tooley.

407. **Porcelain Enamels.** Advanced study in the composition, properties, and processing of porcelain enamels. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 222 and 223, or equivalent. Andrews.

408. **Refractories.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 218 or equivalent. Allen.

409. **Special Ceramic Bodies and Glazes.** Includes laboratory if taken for two units. I or II; 1 to 2 units. Prerequisite: Ceramic Engineering 211 or equivalent. Cook.

495. **Materials and Special Problems.** Conference and laboratory. I or II; 1 to 2 units. Allen, Andrews, Beals, Cook, Friedberg, Lynch, Tooley.

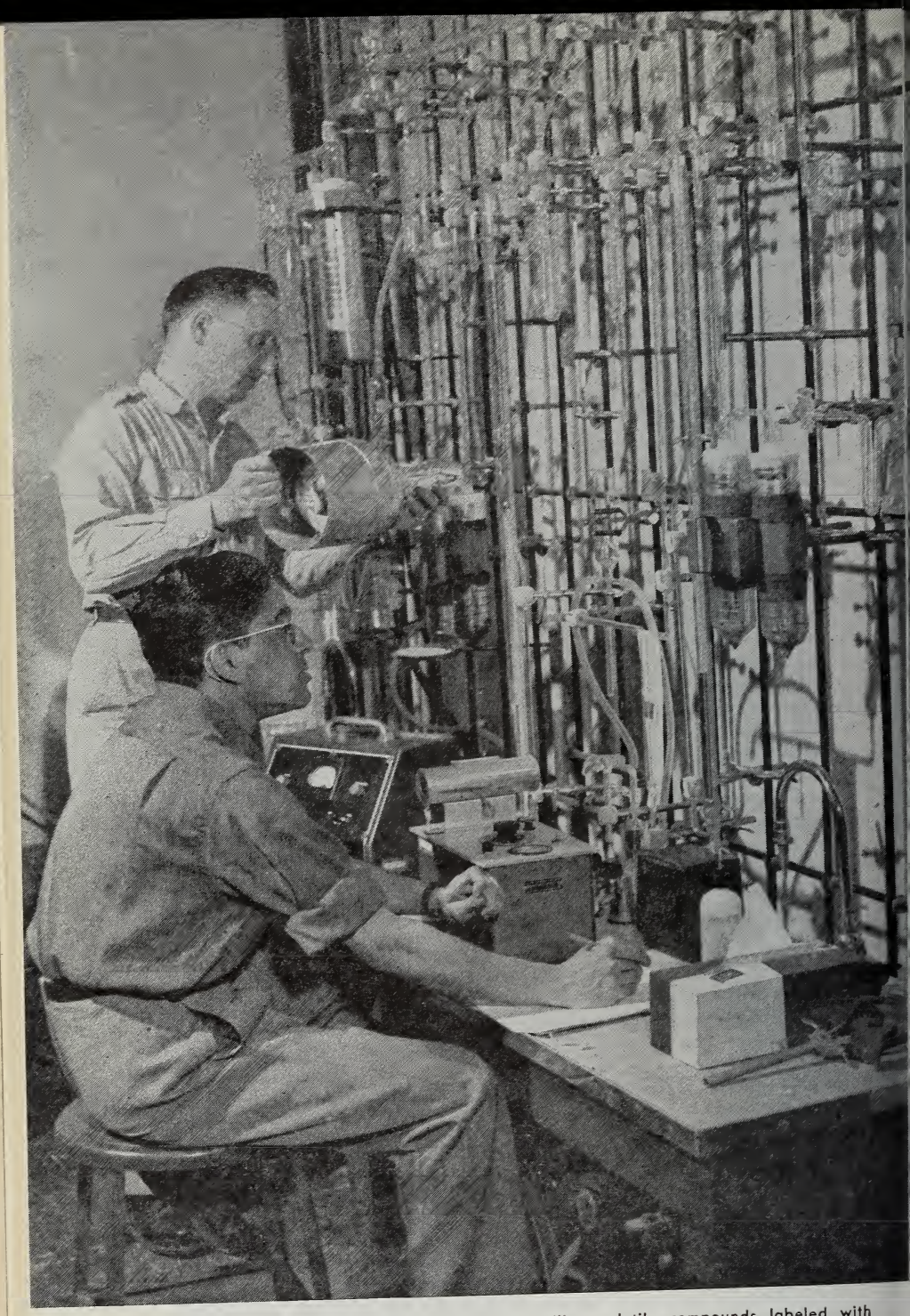
499. **Thesis Research.** Research in any of the branches of ceramics. I, II; 0 to 4 units. Allen, Andrews, Beals, Cook, Friedberg, Lynch, Tooley.

CHEMISTRY AND CHEMICAL ENGINEERING

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering.

Students who have fulfilled the undergraduate course requirements as specified below may apply for entrance to the Graduate College in chemistry or chemical engineering if they have a grade-point average of 4.0.

Students who have completed graduate work in chemistry or chemical engineering and related subjects at another institution may be admitted, provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0. Students whose undergraduate records have not met the above requirements must have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution in order



High vacuum system for handling volatile compounds labeled with radioactive carbon.

to be admitted to the Graduate College in chemistry and chemical engineering.

All students who receive permits to enter the Graduate College in chemistry or chemical engineering, regardless of whether they have had training beyond the bachelor's degree, must take registration examinations. These are offered in the week prior to the opening of the first semester for those entering in the fall, and in the week prior to the opening of the second semester for those entering in February. Those who intend to major in any field of chemistry must take four examinations covering the normal undergraduate instruction in inorganic, analytical, organic, and physical chemistry. Those who intend to specialize in chemical engineering must take two of the examinations in chemistry, one of which must be physical chemistry and the other of the student's own selection; and, in addition, two in chemical engineering covering the usual undergraduate instruction in that subject. The results of these registration examinations are not permanently recorded but serve merely to assist in the registration of students in the proper graduate courses. Students with deficient preparation are required to register in one or more specific courses before taking more advanced work in a particular field. Most of these courses allow graduate residence credit. Students who have received permits to enter the Graduate College in chemistry or chemical engineering should contact the department immediately to learn the dates when these registration examinations are given and to obtain any other detailed information desired.

Students who are candidates for admission to the Graduate College in chemistry or chemical engineering must have had the equivalent of twenty-five semester hours in chemistry properly distributed.

Students who intend to take graduate work for an advanced degree in chemistry or chemical engineering should include in their undergraduate preparation at least the equivalent of one full year of physics, one year of French, one year of German, and mathematics through differential and integral calculus. Any student without the necessary language, physics, or mathematics may enter the Graduate College but is required to spend part of his time in residence to remove the deficiency.

Before taking chemistry or chemical engineering courses for graduate credit, graduate students whose major subject is in some department other than chemistry and chemical engineering must have had the equivalent of fifteen semester hours in chemistry, including satisfactory work in general chemistry, qualitative and quantitative analysis, and elementary organic chemistry. Such students are advised to make selections from the following courses: Chemistry 315, 316, 325, 327, 336, 337, 342, 343, 344, 345, 350, and 355. Courses of a more special nature are not, as a rule, accepted for graduate work unless preceded by one or more of the above courses.

A student majoring in another department who desires a sole minor in chemistry or chemical engineering toward the Doctor of Philosophy degree must include in his program Chemistry 342 and Chemistry 344, or must receive from the physical chemistry division of the department a statement that similar courses taken at other institutions are their equivalent. For fulfillment of the requirements for the sole minor the student must offer a minimum of four units, including credit earned in Chemistry 342 and 344, of which at least two, but usually three, units shall be in a single division of the department.

A student majoring in another department who desires a first minor in a division of the Department of Chemistry and Chemical Engineering toward the Doctor of Philosophy degree must include in his program Chemistry 342 and 343, or must obtain from the head of the physical chemistry division a written statement that similar courses taken at other institutions are their equivalent; in exceptional cases the head of the department may permit the substitution of Chemistry 340 and 341. For fulfillment of such a minor the student shall offer a minimum of one and one-half units of additional course work in a single division

of the department. A student who elects a first minor in one division and a second minor in another division of the department must meet all the requirements set forth for the sole minor in chemistry.

Candidates for the degree of Master of Science in the Teaching of Chemistry must meet the requirements set forth in connection with the Master of Science in the Teaching of the Physical Sciences (page 224).

SPECIAL REQUIREMENTS FOR STUDENTS IN CHEMICAL ENGINEERING

Candidates for advanced degrees in chemical engineering should have had undergraduate training comparable to that offered in the undergraduate chemical engineering curriculum at the University of Illinois. Students who enter without the usual engineering courses are required to make up their deficiencies to the extent prescribed by their adviser. Candidates for the Master of Science degree must include two chemical engineering courses of the 400 sequence in their programs.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in chemistry and chemical engineering may be obtained from the head of the department, 106 Noyes Laboratory.

In addition to University fellowships, the department has a number of fellowships and research assistantships sponsored by industrial concerns and by other organizations. The department also has postdoctoral research appointments available. Application for these should be made to the staff members supervising the research.

GRADUATE TEACHING FACULTY

Professors: H. E. Carter (Head of Department), L. F. Audrieth, J. C. Bailar, Jr., G. L. Clark, E. J. Corey, D. Y. Curtin, H. G. Drickamer, D. T. Englis, R. C. Fuson, I. C. Gunsalus, H. S. Gutowsky, H. F. Johnstone, H. A. Laitinen, N. J. Leonard, C. S. Marvel, T. Moeller, M. S. Peters, T. E. Phipps, H. R. Snyder, S. Swann, Jr., C. S. Vestling, F. T. Wall, P. E. Yankwich.

Associate Professors: Virginia Bartow, H. V. Malmstadt, R. F. Nystrom, J. W. Westwater.

Assistant Professors: D. E. Applequist, R. L. Belford, R. S. Drago, T. J. Hanratty, A. M. Hartley, J. W. Hastings, R. H. Herber, R. S. Juvet, M. Karplus, A. Kuppermann, E. S. Lennox, K. L. Rinehart, W. J. Rutter, K. E. Van Holde, F. Wold.

Instructors: T. L. Brown, B. D. Hall, J. P. Hummel, J. C. Martin, R. A. Smith.

Chemistry

COURSES FOR GRADUATES

402. **Inorganic Chemistry.** The less familiar elements and their relationship in th periodic system. Lectures, reports, and assigned readings. I or II; 1 uni Moeller.

404. **Advanced Inorganic Chemistry Laboratory.** Specialized laboratory tech niques; more difficult inorganic syntheses. II; ¼ to ¾ unit. Prerequisit Credit or registration in one of the lecture courses in inorganic chemistr in the 400 series. Audrieth, Moeller.

405. **Inorganic Chemistry.** Seminar. Required of all graduate students whose major is inorganic chemistry. I, II; ¼ unit. AUDRIETH, BAILAR.

406. **Structures of Inorganic Compounds and Mechanisms of Inorganic Reactions.** Qualitative study of the atomic and molecular orbital description of bonding; applications of these concepts to explain the structure and behavior of inorganic compounds; general formulation of rate processes, description of experimental techniques, treatment of kinetic data, and the elucidation of inorganic reaction mechanisms. I, II; 1 unit. Prerequisite: Chemistry 315. DRAGO, HERBER.

407. **Nonaqueous Solvents and the Chemistry of Hydronitrogens.** Liquid ammonia and nonaqueous systems; nonaqueous solvents as media for chemical reactions; the hydronitrogens and their derivatives. I or II; 1 unit. Prerequisite: Chemistry 315. AUDRIETH.

408. **The Chemistry of Complex Inorganic Compounds.** The nature of the coordinate bond; applications of complex compounds. I or II; 1 unit. Prerequisite: Chemistry 315. BAILAR.

420. **Electronic Instruments in Chemical Analysis.** Discussion of the principles and characteristics of electronic circuits and instruments used for analysis and research in chemistry. Laboratory experimentation and familiarization with basic instrumental components and specific chemical instruments. II; ½ unit. Prerequisite: Chemistry 327, or Chemistry 421 and 422, or consent of instructor. MALMSTADT.

421. **Spectrochemical Methods of Analysis.** Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. I; 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree. MALMSTADT.

422. **Electrical Methods of Chemical Analysis.** Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. II; 1 unit. Prerequisite: Chemistry 344 or equivalent. LAITINEN.

424. **Quantitative Analysis.** Advanced principles, including chemical statistics, calculations, experimental methods, and applications. II; ½ unit.

425. **Analytical Chemistry.** Seminar. Required of all graduate students whose major is analytical chemistry. I, II; ¼ unit. LAITINEN.

426. **Applied X-rays.** Lectures. I; ¾ unit. Prerequisite: Training in physics and physical chemistry. CLARK.

427. **Applied X-rays: Crystallography.** Lectures. II; ¾ unit. Prerequisite: Training in physics and physical chemistry. CLARK.

428. **Applied X-rays.** Laboratory. Training in operation of all types of X-ray apparatus with special emphasis on diffraction; experimental chemical identification and crystal structure analyses from powder and single crystal patterns. I, II; ¼ to 1 unit. Prerequisite: Credit or registration in Chemistry 426 or 427. CLARK.

429. **Electron Microscopy.** Integrated lectures, discussions, demonstrations, and introductory laboratory work for all students. Students may register for credit twice. I, II; ¼ or ½ unit. Prerequisite: Consent of instructor. CLARK.

430. **Organic Chemistry.** Survey of organic chemistry designed for first-year graduate students. I, II; 1 unit. Prerequisite: One year (ten hours) of organic chemistry. CURTIN, FUSON.

432. **Organic Chemistry.** Advanced survey of organic chemistry. To follow Chemistry 430. II; 1 unit. Prerequisite: Chemistry 430 or equivalent. COREY, LEONARD.

433. **Organic Chemistry.** Molecular structure and reaction mechanisms with emphasis on stereochemistry. I; ¾ unit. Prerequisite: Chemistry 430 and 432, or consent of instructor. COREY, CURTIN.

434. **Advanced Organic Synthesis.** I, II; ½ to 1 unit. APPLEQUIST, MARTIN, RINEHART.

435. **Organic Chemistry.** Seminar. Current literature in organic chemistry. I, II; ½ unit. Prerequisite: Consent of instructor. In most cases, students must be doing research in organic chemistry and be registered for the degree of Doctor of Philosophy. ORGANIC STAFF.

436. **Organic Chemistry.** Quantitative organic analysis and newer methods in organic laboratory procedure. A laboratory course designed to acquaint students with newer research techniques. I, II; ½ to 1 unit. COREY.

440. **Physical Chemistry.** Survey of physical chemistry for graduate students. I; 1 unit. Prerequisite: Consent of instructor. PHIPPS.

441. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and calculation of thermodynamic quantities. I; 1 unit. Prerequisite: One year of physical chemistry. GUTOWSKY.

442. **Chemical Thermodynamics.** Continuation of Chemistry 441. II; 1 unit. Prerequisite: Chemistry 441 or consent of instructor. GUTOWSKY.

445. **Physical Chemistry.** Seminar. Required of all graduate students whose major is physical chemistry. I, II; ¼ to ½ unit. Prerequisite: Consent of instructor.

446. **Quantum Chemistry, I.** An introduction to quantum mechanics: basic theory and methods of approximations; applications to atomic systems. I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Chemistry 349 and Mathematics 388, or equivalent; consent of instructor. KARPLUS.

447. **Quantum Chemistry, II.** Continuation of Chemistry 446. Application of quantum mechanics to chemical problems; theories of the chemical bond; structure and spectra of molecules. II; 1 unit. Prerequisite: Chemistry 446 or equivalent; consent of instructor. KARPLUS.

448. **Chemical Kinetics.** Chemical reaction and the theory of rate processes. Lectures. I or II; ¾ unit. Offered in 1958-1959 and in alternate years. Prerequisite: One year of physical chemistry; consent of instructor. YANKWICH.

449. **Special Topics in Physical Chemistry.** An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as molecular spectroscopy, statistical mechanics, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. Students may register for credit more than once. I, II ½ to 1 unit. Prerequisite: Consent of instructor.

450. **Chemistry of Metabolic Processes.** A consideration at the chemical level of biological processes, including energy coupled reactions, biosynthesis, and the degradation of cellular components. Lectures and readings. I; ¾ unit Prerequisite: Chemistry 350 and 355, or equivalent. GUNSALUS.

452. **Experimental Techniques in Biochemistry.** Experiments on the isolation purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. I, II; ½ to 1 unit. Prerequisite: Chemistry 350 and 355. WOLD.

455. **Biochemistry.** Seminar. Discussions of current research and literature. Re-

quired of all graduate students whose major is biochemistry. I, II; ½ unit. Prerequisite: Chemistry 350 and 355, or equivalent. GUNSALUS.

492. **Chemical Literature and Reference Work.** I; ¼ unit. BARTOW.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Animal Nutrition 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. II; 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor.

499. **Thesis Research.** Candidates for the Master of Arts or Master of Science degree who elect research are required to present a thesis. A thesis is always required of students working toward the degree of Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. I, II; 0 to 4 units. Work may be taken in the following fields, subject to the approval of one of the qualified staff members:

Analytical Chemistry. CLARK, ENGLIS, LAITINEN, MALMSTADT.

Biochemistry. CARTER, GUNSALUS, HASTINGS, LENNOX, RUTTER, VESTLING, WOLD.

Inorganic Chemistry. AUDRIETH, BAILAR, HERBER, MOELLER.

Organic Chemistry. COREY, CURTIN, FUSON, LEONARD, MARVEL, SNYDER.

Physical Chemistry. BELFORD, DRICKAMER, GUTOWSKY, HALL, HUMMEL, KARPLUS, KUPPERMANN, PHIPPS, VAN HOLDE, WALL, YANKWICH.

Chemistry:

Applied Electrochemistry (Organic and Inorganic). SWANN.

Radiocarbon Chemistry. NYSTROM.

Students who intend to major in chemistry in one of these special fields should consult with the professor in charge of the thesis and with the head of the Department of Chemistry and Chemical Engineering in regard to the program of courses and examinations.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Inorganic Chemistry.** Nuclear and extranuclear atomic structures and their relation to the properties of the elements and of their compounds; types of bonding; survey of the periodic relationships; preparation, and applications of the elements and their compounds. I, II; ¾ unit. Prerequisite: Fifteen hours of credit in chemistry courses exclusive of courses numbered below 110. AUDRIETH, MOELLER.

316. **Inorganic Chemistry.** Preparation of typical inorganic compounds illustrating special and more advanced techniques. I, II; ½ unit. Prerequisite: Credit or registration in Chemistry 315. AUDRIETH, MOELLER.

324. **Introductory Microanalysis and Microscopy.** Qualitative spot tests, crystal tests, microscopic techniques; quantitative microvolumetric and gravimetric methods. Lectures and laboratory. I; ¾ unit. Prerequisite: Chemistry 124 or equivalent.

325. **Analytical Chemistry.** A survey course for advanced undergraduate and graduate students requiring further training and review in analytical chemistry. I; ¾ unit. Prerequisite: Advanced standing in chemistry. LAITINEN.

326. **Chemical Analysis and Treatment of Water.** Chemical and instrumental methods for analysis of water and determination of quality; chemical principles and processes in water purification and conditioning; relationship of chemistry of water to municipal and industrial use. I; ¾ unit. Prerequisite: Chemistry 124. ENGLIS.

327. **Special and Instrumental Methods of Analysis.** Electrical and optical methods, and other advanced analyses. I, II; ¾ unit. Prerequisite: Chemistry 124, 234, 342, and 343; or consent of instructor. JUVET, MALMSTADT.

328. **Organic Functional Group Analysis.** A study of the quantitative separation and determination of organic compounds via functional groups: instrumental, manometric, gravimetric, and volumetric methods. II; ¾ unit. Prerequisite: Chemistry 124 and 336 or equivalent. JUVET.

329. **Food Analysis.** Quantitative organic analysis of food products; alcohols, carbohydrates, fats and oils, cereals, nitrogenous bodies, preservatives, and colors. II; 1¼ units. Prerequisite: Chemistry 122 or 124, and 133 or 234. ENGLIS.

333. **Applied Electrochemistry.** Use of electric current through solutions for carrying out reactions. Lectures. Open to students in the curriculum in chemistry and chemical engineering. II; ½ unit. Prerequisite: Chemistry 234, 336, and 344. SWANN.

336. **Organic Chemistry.** Second course. Lectures and recitations. I, II; ¾ unit. Prerequisite: Chemistry 124 and 234. FUSON, MARVEL.

337. **Organic Chemistry.** Laboratory experiments in organic chemistry. I, II; ½ unit. Prerequisite: Chemistry 234; credit or registration in Chemistry 336. APPLEQUIST, MARTIN.

338. **Systematic Identification of Organic Compounds.** I, II; ¾ unit. Prerequisite: Chemistry 336 and 337, or equivalent. LEONARD, RINEHART.

339. **Theoretical Organic Chemistry.** Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free radicals, and carbanions. II; ¾ unit. Prerequisite: Chemistry 338 or consent of instructor. APPLEQUIST.

340. **Elementary Physical Chemistry.** A one-semester course in chemical principles with emphasis on topics and applications most important to students in agriculture, the biological sciences, and pre-medicine, and to graduate students needing a brief foundation course. Not open to students in the specialized curricula in chemistry or chemical engineering. I; ¾ unit. Prerequisite: Physics 102 or 104, Chemistry 122 and 133, or equivalent; registration in Chemistry 341. HALL, VAN HOLDE.

341. **Elementary Physical Chemistry Laboratory.** To accompany Chemistry 340. Quantitative experiments chosen to emphasize basic principles and also to acquaint the students with important laboratory techniques. I; ¼ unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry. HALL, VAN HOLDE.

342. **Physical Chemistry.** This course and Chemistry 344 constitute a one-year study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. I, II ¾ unit. Prerequisite: Chemistry 124; Physics 106, 107, and 108, or two semesters of general physics with registration in the third semester; credit or registration in Mathematics 142 (preferred) or 147; or equivalents. BELFORD YANKWICH.

343. **Physical Chemistry Laboratory.** Quantitative experimental study of chemical principles. Chemistry 343 and 345 constitute a one-year introduction to experimental physical chemistry. They may be taken consecutively or concurrently. I, II; ¼ unit. Prerequisite: Chemistry 342. BELFORD, KUPPERMANN

344. **Physical Chemistry.** Continuation of Chemistry 342. I, II; ¾ unit. Prerequisite: Chemistry 342. BELFORD, YANKWICH.

345. **Physical Chemistry Laboratory.** Continuation of Chemistry 343. May be taken concurrently with Chemistry 343. I, II; ¼ unit. Prerequisite: Chemistry 342; credit or registration in Chemistry 343 and 344. BELFORD, KUPPERMANN.

346. **Physical Chemistry of Macromolecules.** The physical properties of systems containing large molecules, with special emphasis on proteins and high polymers; the use of physical methods for the characterization of such substances. I; ¾ unit. Prerequisite: Chemistry 344 or consent of instructor. VAN HOLDE.

347. **Colloid and Surface Chemistry Laboratory.** To accompany Chemistry 249 or 346. Individual experiments in colloid and surface chemistry. I, II; ¼ unit. Prerequisite: Credit or registration in Chemistry 249 or 346, or consent of instructor. HALL, VAN HOLDE.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. Graduate students registering for one unit do a special project. I; ¾ or 1 unit. Prerequisite: Chemistry 344 or equivalent. KARPLUS.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. Graduate students registering for one unit do a special project. II; ¾ or 1 unit. Prerequisite: Chemistry 348. KARPLUS, YANKWICH.

350. **General Biochemistry.** The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings. I, II; ¾ unit. Prerequisite: Chemistry 122 or 124, and 133 or 234, or equivalent; registration in Chemistry 355. CARTER, LENNOX, VESTLING.

351. **Metabolic Processes, Problems and Methods.** Laboratory experiments stress methods of conducting metabolic experiments with tissues, cells, cell components, and enzymes. Weekly discussions consider present concepts of the mechanism of chemical transport, hormone control, energy release, and of biosynthesis. II; ¾ unit. Prerequisite: Chemistry 350 and 355. HASTINGS.

352. **Biochemistry of Vitamins and Hormones.** Transformation of micronutrients including their biosynthesis, functional forms, and sites of action; chemistry and functional role of hormones and other regulatory compounds. II; ¾ unit. Prerequisite: Chemistry 350 and 355, or equivalent. LENNOX.

354. **Introduction to Biochemistry.** Lectures: Structure and function of living matter, with emphasis on the mammalian organism. Laboratory: The isolation, chemical characterization, and function of the structural and catalytic components of living cells. This course is designed primarily to meet the needs of veterinary medicine, nutrition, dietetics, and other professional students. Open to other students only by special permission when space is available. This course does not meet the requirements for registration in advanced courses in biochemistry. I; 1 unit. Prerequisite: Chemistry 122 or 124 and 133 or 234, or equivalent; laboratory course in general biology, botany, or zoology; or consent of instructor. HASTINGS, VESTLING.

355. **Biochemistry Laboratory.** An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance;

identification and quantitative measurement of constituents and transformations in biological systems. Laboratory, quizzes, and readings. To accompany Chemistry 350. Required of all students who expect to take advanced courses in biochemistry. I, II; ¾ unit. Prerequisite: Chemistry 122 or 124; Chemistry 133 or 234, or equivalent; registration in Chemistry 350. GELLER, RUTTER.

358. **Chemistry of Biological Catalysis.** Formation, properties, structure, and mechanism of action of enzymes and other biocatalysts. Lectures and readings. II; ¾ unit. Prerequisite: Chemistry 350 and 355, or equivalent. RUTTER.

391. **Special Problems in the Teaching of High School Chemistry.** Designed to strengthen the chemical background of high school teachers and to integrate teaching of high school and college chemistry courses. Lectures, conferences, problems, and reports. Adapted to individual needs. I, II; ½ to 1 unit. Prerequisite: Experience in high school chemistry teaching. AUDRIETH.

394. **Principles of Chemical Thermodynamics.** Thermodynamics and free energy calculations. I, II; ¾ unit. Prerequisite: Chemistry 342 and 344 or consent of instructor. PHIPPS.

395. **History of Science with Particular Reference to Chemistry.** I; ¼ unit. Prerequisite: Twenty hours of laboratory science. BARTOW.

396. **Atomic Physics.** Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics include the atomic nature of matter, the properties of free electrons, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, an introduction to the ideas of quantum mechanics, binding in molecules and crystals, and in an introduction to some solid state phenomena. It is recommended that chemistry majors take Chemistry 344 before registering in this course. I, II; 1 unit. Prerequisite: General physics and Mathematics 343 or 345, or consent of instructor.

397. **Radiochemistry.** Same as Nuclear Engineering 397. Properties of radioactive nuclei, nature of radioactivity, nuclear reactions, detection equipment, and tracer technique. Lectures. I, II; ½ unit. Prerequisite: One semester of physical chemistry or consent of instructor. HUMMEL.

398. **Radiochemistry.** Same as Nuclear Engineering 398. Laboratory to accompany Chemistry 397. I, II; ¼ unit. Prerequisite: Credit or registration in Chemistry 397, or consent of instructor.

Chemical Engineering

COURSES FOR GRADUATES

464. **Diffusional Operations.** The principles of countercurrent and stagewise mass transfer and their application to practical problems of separation. Lectures. II; 1 unit. Prerequisite: Chemical Engineering 373. DRICKAMER, PETERS.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. I, II; ¼ unit. Prerequisite: Chemical Engineering 373. DRICKAMER, PETERS.

466. **Applied Mathematics in Chemical Engineering.** Setting up and solving the boundary value problems which frequently occur in chemical engineering. II; ¾ to 1 unit. Prerequisite: Mathematics 343, 345 or equivalent, or consent of instructor. HANRATTY, QUINN.

467. **Distillation.** Application of principles of distillation to binary and multicomponent mixtures including a discussion of azeotropic and extractive distillation. II; ¾ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Chemical Engineering 373. DRICKAMER.

468. **Advanced Plant Design.** Chemical engineering kinetics as used in the design of plants. Lectures. II; ¾ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Chemical Engineering 373; consent of instructor. PETERS.

469. **Special Topics in Chemical Engineering.** The prediction of physical properties from the molecular theories of matter. II; ¾ to 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Mathematics 343 and 345, or consent of instructor. DRICKAMER.

487. **Flow of Fluids.** Advanced course. Lectures, recitations, and problems. I; ¾ unit. Prerequisite: Chemical Engineering 371, or equivalent with consent of instructor. HANRATTY.

488. **Heat Transmission.** Advanced course. Lectures, recitations, and problems. I; ¾ unit. Prerequisite: Chemical Engineering 371, or equivalent with consent of instructor. WESTWATER.

499. **Thesis Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the degree of Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another department must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. I, II; 0 to 4 units. DRICKAMER, HANRATTY, JOHNSTONE, PETERS, SWANN, WESTWATER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Process Engineering.** Same as Food Technology 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food technology; not open to majors in chemical engineering. Lectures and problems. I; ¾ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Chemistry 340 and 341 or 342; one year of calculus.

370. **Chemical Engineering Thermodynamics.** The fundamental concepts and laws of thermodynamics. Primarily for students in chemical engineering. II; ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 342.

371. **Principles of Chemical Engineering.** Scientific principles in unit operations of chemical engineering. Lectures, problems, and quizzes. I, II; 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor. HANRATTY, PETERS.

373. **Principles of Chemical Engineering.** Scientific principles in unit operations of chemical engineering. Lectures, problems, and quizzes. I, II; 1 unit. Prerequisite: Chemical Engineering 371. DRICKAMER, WESTWATER.

374. **Unit Operations Laboratory.** To accompany Chemical Engineering 373. Laboratory and computations in the unit operations. I, II; ½ unit. Prerequisite: Credit or registration in Chemical Engineering 373. HANRATTY.

377. **Chemical Engineering Technology.** Study of industrial chemical processes and principles. II; ½ unit. Prerequisite: Chemical Engineering 261.

379. **Chemical Engineering Projects.** Laboratory. Development of an individual project. I, II; ½ unit. DRICKAMER, WESTWATER.

380. **Chemical Engineering Calculations.** Numerical and graphical methods for problems in equilibria and kinetics. Lectures and recitations. II; ¾ unit. Prerequisite: Chemistry 394; Chemical Engineering 371. HANRATTY.

381. **Chemical Engineering Plant Design.** Comprehensive problems. I, II; ½ unit. Prerequisite: Chemical Engineering 373. PETERS.

382. **High Pressure Reactions.** Lectures, recitations, and problems. I; ½ unit. Prerequisite: Consent of instructor. DRICKAMER.

CITY PLANNING AND LANDSCAPE ARCHITECTURE

The Department of City Planning and Landscape Architecture offers graduate work leading to the Master of Fine Arts and Master of Science degrees. Students applying for admission must have a grade-point average of at least 3.5.

Degree of Master of Science in City Planning. College graduates in liberal arts and sciences as well as architecture, city planning, civil engineering, and landscape architecture are offered an opportunity to prepare themselves for careers in city, state, and regional planning. After completing their preparation they are qualified for positions with city, metropolitan, state, and regional planning commissions.

The prerequisite for graduate work in city planning is a bachelor's degree and must include courses of the following character or their equivalents: city planning (introductory), three hours; sociology (urban, rural, or regional), three hours; political science (municipal government; public administration), three hours; economics (urban land economics; public finance), three hours; geography (urban or rural), three hours; design (skill in graphic expression; landscape, architectural, or highway and municipal design; regional design), twelve hours.

To qualify for this degree a student must take the seminar and thesis courses for three units and at least five additional units chosen from the following fields: architecture, city planning, civil engineering, economics, geography, political science, sociology.

Degree of Master of Fine Arts in Landscape Architecture. The prerequisite for graduate work in landscape architecture is a bachelor's degree in landscape architecture substantially equivalent to the degree conferred by the University of Illinois.

To qualify for this degree a student must take the seminar and thesis courses for three units and at least five additional units chosen from the following: architecture, botany, city planning, civil engineering, landscape architecture.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in city planning and in landscape architecture may be obtained from the head of the department, 205 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: L. B. WETMORE (Head of Department), W. I. GOODMAN, W. M. KEITH, S. H. WHITE.

City Planning

COURSES FOR GRADUATES

437. **Advanced City Planning Design.** Analysis and synthesis of problems and possibilities in the layout of average towns and cities and their surroundings. I, II; 1 to 2 units. Prerequisite: City Planning 337 and 338, or consent of instructor.

487. **Seminar.** I, II; ½ unit.

488. **City Planning Research.** Individual and group instruction in application of professional training in city planning and other fields to the analysis of urban planning problems and to the development of approaches to solution of these problems. I, II; ½ to 2 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **City Planning Design.** I; 1 unit. Prerequisite: Landscape Architecture 236 or consent of instructor.

338. **City Planning Design.** II; 1 unit. Prerequisite: City Planning 337 or consent of instructor.

372. **Theory and Practice.** The unified development of communities; comprehensive arrangement of land uses and land occupancy. I, II; ½ unit.

376. **Planning Procedures, Methodologies, and Practice.** Procedures involved in major types of planning services, special planning studies, planning techniques and methodologies, organization and administration of planning staffs and agencies, professional practice. I; ½ unit. Prerequisite: Consent of instructor.

378. **Planning Administration and Legislation.** Legal tools of planning, zoning, subdivision regulations, housing codes, methodology and application; administrative procedures of planning; the place of planning in the structure of government; the capital improvement program. II; ½ unit. Prerequisite: Political Science 150 or 151, 305 or 306, or consent of instructor.

Landscape Architecture

COURSES FOR GRADUATES

436. **Advanced Landscape Design.** Landscape design of large private, semi-public, and public properties. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

447. **Advanced Landscape Construction.** Construction problems connected with large private and public landscape developments. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

457. **Advanced Planting Design.** Theory and application of planting design in relation to private, semi-public, and public properties. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture. WHITE.

487. **Seminar.** I, II; ½ unit.

499. **Thesis Research.** I, II; ½ to 2 units. STAFF.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The graduate student in civil engineering generally follows one of three fields: transportation and municipal engineering, hydraulic engineering, or structural engineering, including soil mechanics and foundations. The work leads to the degree of Master of Science in Civil Engineering and to the degree of Doctor of Philosophy in Engineering. A prerequisite for graduate work in civil engineering is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired.

The work in sanitary engineering leads to the degree of Master of Science in Sanitary Engineering and to the degree of Doctor of Philosophy in Engineering.

The prerequisite for admission to the first year of graduate study is a degree of Bachelor of Science in Sanitary Engineering or the satisfactory completion of the sanitary option in a course in civil engineering, including basic courses in bacteriology, quantitative chemical analysis, and organic chemistry, or their equivalent in the fields of chemistry and biology.

The minimum grade-point average for admission to graduate study in civil engineering or sanitary engineering is 3.75.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or a minor are subject to the review of and must be approved by the head of the department.

A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units of formal course work are required.

A pamphlet, entitled "Graduate Study and Research in Civil and Sanitary Engineering," describing the opportunities for graduate work and research in the Department of Civil Engineering, is available upon request to the head of the department, 205 Civil Engineering Hall, Urbana, Illinois.

For information concerning applied mathematics, see page 196.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in civil engineering may be obtained from the head of the department, 205 Civil Engineering Hall.

GRADUATE TEACHING FACULTY

Professors: N. M. Newmark (Head of Department), W. C. Ackermann E. E. Bauer, J. W. Briscoe, E. Danner, D. U. Deere, G. H Dell, J. E. Duberg, E. H. Gaylord, W. W. Hay, W. H. Munse W. A. Oliver, R. B. Peck, M. O. Schmidt, C. P. Siess, T. H Thornburn.

Associate Professors: W. J. Austin, J. E. Baerwald, V. T. Chow, R. S. Engel brecht, J. C. Guillou, W. J. Hall, J. D. Haltiwanger, H. O Ireland, N. Khachaturian, M. F. Lindeman, J. W. Massard V. J. McDonald, R. J. Mosborg, G. K. Sinnamon, J. E. Stall meyer, A. S. Veletsos.

Assistant Professors: T. Y. Chen, N. Chryssafopoulos, E. Y. Huang, H. M Karara, M. A. Sozen.

Lecturer: K. Terzaghi.

COURSES FOR GRADUATES

401. **Geodetic Engineering.** Elements of geodesy; principles and practice of pre cise triangulation, traverse, and levels. I; 1 unit. Prerequisite: Bachelor o Science degree in civil engineering. Schmidt.

402. **Geodetic Engineering.** Astronomic determination of latitude, longitude, an azimuth; systems of plane coordinates; map projections; electronic an special control surveys. II; 1 unit. Prerequisite: Bachelor of Science degre in civil engineering. Schmidt.

420. **Highway Pavement Design, I.** Analysis and methods of measurement of roa surface properties related to vehicle performance; factors affecting pavemer durability; traffic wear, climate, chemical action, combined effects; compo sition design of flexible and rigid pavements for proper road surface prop erties, load carrying capacity, wear resistance, stability and durability. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. Danner.

421. **Highway Pavement Design, II.** Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. II; 1 unit. Prerequisite: Civil Engineering 420 or consent of instructor. DANNER.

422. **Municipal Administration and Engineering.** Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and zoning, building codes and inspection; street lighting; public utilities; city cleaning; recreational development. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. DANNER.

423. **Traffic Planning.** Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. II; 1 unit. Prerequisite: Civil Engineering 323 or equivalent. BAERWALD.

425. **Railroad Location and Operation.** Track and traffic capacity, optimum size of train, train performance diagram, train scheduling and make-up, improvement of existing lines, examples of modern location. I; 1 unit. Prerequisite: Civil Engineering 203, 226, or equivalent experience, or consent of instructor. HAY.

426. **Railroad Location and Operation.** Roadbeds under load, roadbed stabilization, design of ballast section, ties, rails, and fastenings, economics of grade separation, recent examples of roadway and track problems. II; 1 unit. Prerequisite: Civil Engineering 425, or equivalent, or consent of instructor. HAY.

40. **Water Supply.** Water resources and use; design, construction, and operation of water distribution systems. I; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent.

43. **Sewerage.** Design, construction, maintenance, operation, and financing of sewer systems. II; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent.

44. **Sewage Disposal, Wastes Disposal, and General Sanitation.** Fundamental principles and practical considerations associated with sewage and industrial waste disposal, including the design, operation, and control of the various treatment units. II; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent. ENGELBRECHT.

46. **Water Purification and General Sanitation.** Fundamental principles and practical considerations associated with water treatment, including the design, operation, and control of the various unit processes. I; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering or equivalent.

48. **Sanitary Engineering Laboratory.** Laboratory evalution of the various unit processes practiced in water, sewage, and industrial waste treatment; their application, significance, and control. I, II; 1 to 2 units. ENGELBRECHT.

0. **Hydrology and Flood Control.** Magnitude and frequency of flood flow of streams, minimum flow of streams and regulation of flow by storage reservoirs; intense rainfall and the development of intensity curves for use in rational run-off formula; unit-graph method of computing flood run-off; flood control and prevention by channel improvement, levees, and reservoirs. I; 1 unit. Prerequisite: Civil Engineering 250 or equivalent. CHOW.

2. **Water Resources Planning and Development.** Purposes and techniques of planning water resources developments; methods of evaluating the engineer-

ing and economic aspects of water conservation projects developed through the examination of actual proposals. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. GUILLOU.

455. **Water Power Engineering.** Preliminary investigations of site, available water supply, machinery selection, design of water passages, arrangement and space allocation in power houses, load curve studies, hydrosteam association, and speed and pressure regulation. II; 1 unit. Prerequisite: Civil Engineering 250 or 450. YOUNG.

456. **Hydraulics of Surface Drainage.** Applications of hydraulic and hydrologic principles; elements of channel design, hydrologic determination of design flow, hydraulics of culverts and bridge openings, overland flow, flow in gutters and inlets, and hydrologic and hydraulic design of a bridge opening or culvert system. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234; or equivalent. GUILLOU.

458. **Open Channel Flow.** Classification of types of flow, channel roughness, backwater curve computations, hydraulic jump analysis, special transitions canal design, study of supercritical velocity flow, unsteady flow and flood movements; modern developments in open channel flow theory and design practice. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. CHOW.

460. **Structural Analysis.** Basic theory of indeterminate structures; deflections and displacements; continuous beams and frames; virtual work; qualitative and quantitative influence lines. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with a course in theory of simple structures. OLIVER.

461. **Structural Theory and Design.** General theory of continuity; moment distribution; the column analogy; rigid frame bridges and buildings; fixed and continuous arches; inelastic behavior of structures; classification of structures from viewpoint of design. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering with a fundamental course in indeterminate structures. HALL.

462. **Structural Theory and Design.** Statically indeterminate trusses; continuous trusses, steel arches; secondary stresses; suspension bridges; long-span roofs; skeleton steel buildings. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering with a fundamental course in indeterminate structures. MOSBORG.

463. **Analysis and Design of Prestressed Concrete Structures.** The principles of linear prestressing; study of materials used in prestressed concrete; methods of linear prestressing; design of simple beams on the basis of working stresses and on the basis of the ultimate load; statically indeterminate prestressed concrete structures; design of continuous prestressed concrete beams. I, II; 1 unit. Prerequisite: Bachelor of Science degree in civil or architectural engineering with courses in structures and reinforced concrete design. KHACHATURIAN.

464. **Reinforced Concrete Design.** Theories of action of beams, slabs, and columns of reinforced concrete; codes and specifications and their influence on design; effect of continuity. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with courses in structures. BRISCOE.

465. **Steel Design.** Design of steel members; codes and specifications for building riveted and welded connections; evolution of bridge specifications; loads and working stresses; economic proportions. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with courses in structures. GAYLORD.

466. **Behavior of Reinforced Concrete Members.** Studies of the actual behavior and strength of reinforced concrete members by means of critical reviews

the more significant experimental and analytical investigations. Emphasis is placed on the empirical nature of current design specifications and their relation to the results of research. Beams subjected to pure flexure, columns subjected to axial compression, combined flexure and axial compression, combined flexure and shear, and bond. I; 1 unit. Prerequisite: Bachelor of Science degree in civil or architectural engineering with courses in structures and reinforced concrete design. SIESS, SOZEN.

467. **Behavior of Reinforced Concrete Structures.** Continuation of Civil Engineering 466. Studies of behavior and strength of statically indeterminate reinforced concrete structures and structural elements: frames, floor slabs in buildings, isolated column footings. II; 1 unit. Prerequisite: Civil Engineering 466 or consent of instructor. SIESS.

469. **Wood Structures.** Theory and practice in the design of modern wood structures; the effect of the plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. I, II; 1 unit. Prerequisite: Bachelor of Science degree in civil, architectural, or agricultural engineering, or consent of instructor. OLIVER.

470. **Earth Pressures and Retaining Walls.** A study of earth pressures considering the significant properties of soils; methods of computing earth pressures and the limitations in their dependability; stability computations; and the design and construction of retaining walls and abutments. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. DEERE, PECK.

471. **Earth and Masonry Dams.** Stability of rolled-fill and hydraulic-fill earth dams and rock-filled dams; methods of construction; seepage losses; control of seepage forces; safety of foundations; solid gravity, arched gravity, arch, multiple arch and slab and buttress dams; safety against sliding and overturning; unit stresses on horizontal sections and principal stresses; joints; drainage; foundations. II; ½ to 1 unit. DEERE, PECK, YOUNG.

473. **Soil Mechanics.** Advanced studies of research techniques in soil mechanics and foundation engineering. I; 1 unit. Prerequisite: Civil Engineering 374 or consent of instructor. PECK.

474. **Foundation Engineering.** Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. II; 1 unit. Prerequisite: Credit or registration in Civil Engineering 374 or consent of instructor. DEERE, PECK.

475. **Soil Engineering for Transportation Facilities.** Problems of soil classification; factors affecting the stability of subgrades, slopes, and embankments. I; 1 unit. Prerequisite: Civil Engineering 373 or equivalent. THORNBURN.

481. **Numerical and Approximate Methods of Structural Analysis.** Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns, moments and deflections of beams resting on elastic or plastic supports, vibration of beams, analysis of arches, moments and deflections of plates, and other problems. I, II; 1 to 2 units. AUSTIN, CHEN.

482. **Advanced Numerical Methods in Engineering.** Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, characteristic value problems, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures, blast, impact, and earthquake effects on

structures, buckling and flexure of frameworks, torsion of solid and thin-walled sections, lateral buckling of beams, bending and buckling of plates and of stiffened plates, plane stress and axially symmetric problems in elasticity, and other topics. II; 1 to 2 units. Prerequisite: Civil Engineering 481. AUSTIN.

483. **Analysis and Design of Plates and Shells.** Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highway and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs and hipped plate construction. I; 1 to 2 units. Prerequisite: Consent of instructor. VELETSOS.

484. **Behavior of Structures Under Dynamic Loads.** Free vibrations, forced vibration, and transient response of structures and structural components having one or many degrees of freedom; analytical methods for the effects of wind load, explosion blast, impact, earth tremors, and other time dependent excitations; effects of damping and inelastic action; propagation of stress waves; wind induced vibrations with application to cables, pipelines, and tall stacks. II; 1 to 2 units. Prerequisite: Consent of instructor. VELETSOS.

485. **Behavior of Steel Structures.** Studies of the behavior of metal structures; significance in terms of design and development of specifications; critical evaluations of experimental investigations of columns, beams, and frames loaded to failure; strength of riveted, bolted, and welded connections; brittle fracture; fatigue; and impact. I or II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. MUNSE.

486. **Design of Lightweight Structures.** Analysis and design of structures and structural members of minimum weight. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree with previous work in statically indeterminate structures. GAYLORD.

487. **Design of Structures for Dynamic Loads.** Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast resistant structures; criteria for design of earthquake resistant structures; application to actual problems. I; 1 to 2 units. HALTIWANGER, NEWMARK.

493. **Special Problems.** Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who supervises the work. I, II; 0 to 4 units.

495. **Highway and Traffic Seminar.** Presentation and discussion of current problems and research developments in highway transportation, administration, and engineering. Should be followed by Civil Engineering 496. I; no credit BAERWALD, DANNER.

496. **Highway and Traffic Seminar.** Continuation of Civil Engineering 495. Presentation and discussion of current problems and research developments in highway transportation, administration, and engineering. II; no credit BAERWALD, DANNER.

499. **Thesis Research.** I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Photogrammetric Engineering.** A study of metrical photography in civi engineering practice; characteristics and interpretation of aerial and ter restrial photographs; stereoscopic compilation of maps from photographs mosaics; economics of photogrammetry; map reproduction. I, II; ½ unit

Prerequisite: Civil Engineering 207 (Summer Surveying Camp), senior standing, or consent of instructor. KARARA.

319. **Advanced Surveying.** Advanced problems in topographic engineering; control surveys, special mapping projects, construction surveys, and special surveys. The utilization of maps and survey data in civil engineering practice. II; ½ unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp); senior standing, or consent of instructor. SCHMIDT.

323. **Highway Traffic Characteristics.** Driver characteristics, vehicle characteristics, and traffic behavior as related to highway design and operation; traffic planning studies; field problems. I; 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor. BAERWALD.

324. **Airport Design.** Specifications and regulations; site selection, soil investigation, layout, drainage, pavement, buildings, hangars, and other engineering features of airport design and construction; management, operation, and maintenance. II; ½ to 1 unit. Prerequisite: Senior standing in civil engineering or consent of instructor. CHRYSSAFOPOULOS.

332. **Engineering Properties of Soils.** Laboratory practice in testing, identification, and classification of soils; study of development of test procedures and basic theories involved; calculations and preparation of graphs using test data. Tests include those for classification, determination of physical properties, and job control. I, II; ½ unit. Prerequisite: Senior standing in engineering or consent of instructor. BAUER.

344. **Water and Sewage Treatment.** Principles, design, and operation of water purification and sewage treatment works; correlation of these aspects with various laboratory control tests, their application, interpretation, and limitations as used in practice. I; 1 unit. ENGELBRECHT.

345. **Public Health Engineering.** The application of engineering principles to the control of environmental sanitation, including disease and immunity, epidemiology, biostatics, industrial hygiene, atmospheric pollution, housing, refuse collection and disposal, milk and food sanitation, and plumbing. II; ½ unit. ENGELBRECHT.

355. **Water Power Engineering.** Analysis of hydrologic and power market data; selection of site and hydraulic machinery; preliminary design of water passages and power house; formal reports on projects. II; 1 unit. Prerequisite: Senior standing. YOUNG.

356. **Hydraulic Engineering Laboratory.** Fundamental principles, operation and use of model laboratories, dimensional analysis, hydraulic similitude, theory and design of hydraulic models. II; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. GUILLOU.

361. **Statically Indeterminate Structures.** Elastic theory and its applications to statically indeterminate structures. I, II; ½ unit. Prerequisite: Civil Engineering 262; credit or registration in Civil Engineering 264.

362. **Statically Indeterminate Structures.** Continuation of Civil Engineering 361. I, II; ½ unit. Prerequisite: Civil Engineering 361, or 262 and consent of instructor.

370. **Foundations and Retaining Walls.** Evaluation of subsoil conditions as they affect the behavior, proportions, and choice of type of foundations; relations between foundation and other structural problems; design and construction of retaining walls and abutments including the study of earth pressure theories; applicability of analytical methods used to other problems involving natural phenomena. I, II; ¾ to 1 unit. Special problems are required of students who register for one unit. Prerequisite: Civil Engineering 230 and 263. DEERE, IRELAND.

371. **Earth and Concrete Dams.** Design and construction of earth dams and embankments and concrete dams. I, II; ½ unit. Prerequisite: Credit or registration in Civil Engineering 264 and 370, or consent of instructor. YOUNG.

373. **Soil Mechanics.** Identification, description, and physical properties of soils; subsurface exploration; engineering characteristics of natural deposits of soil. I; ½ or 1 unit. Prerequisite: Graduate standing, or credit or registration in Civil Engineering 370. DEERE, IRELAND.

374. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; braced cuts and tunnels; damage due to construction operations. II; ½ or 1 unit. Prerequisite: Civil Engineering 373. DEERE, IRELAND, PECK.

375. **Engineering Aspects of Surficial Soils.** Use of geologic, pedologic, and air-photo information for identification and evaluation of the engineering properties of surficial soils. II; 1 unit. Prerequisite: Civil Engineering 230 or consent of instructor. THORNBURN.

THE CLASSICS

The Department of Classics offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

The degree of Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the degree of Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. In all cases, the requirement of a master's thesis is waived; extra units of work in Greek or Latin are substituted for the thesis.

The degree of Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

The minimum grade-point average for admission to graduate study in the department is 3.5. All graduate students should take Greek or Latin 495-496, Bibliography and Criticism, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a mimeographed bulletin which may be obtained by applying to the head of the department, 138 Lincoln Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in classics may be obtained from the head of the department, 138 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: J. L. HELLER (Head of Department), R. P. OLIVER, B. E. PERRY, A. TURYN.

Classics in Translation

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Classical Literary Traditions, I.** Greek literature from Homer to Aristotle. I; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Knowledge of Greek or Latin is not required. PERRY.

302. **Classical Literary Traditions, II.** Literary forms in the Alexandrian and Roman periods. II; ½ unit. Prerequisite: Completion of the foreign lan

guage requirement in the College of Liberal Arts and Sciences, or equivalent. Knowledge of Greek or Latin is not required. PERRY.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered on demand. Consult the departmental office, 138 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. **Greek Versification.** Greek prosody: survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. I, II; 1 unit. TURYN.

411. **Hellenistic Literature.** I, II; 1 unit. PERRY.

412. **Lucian and His Age.** I, II; 1 unit. PERRY.

413. **Greek Lyric Poetry.** I, II; 1 unit. TURYN.

414. **Pindar and Bacchylides.** I, II; 1 unit. TURYN.

415. **Homer.** I, II; 1 unit. TURYN.

416. **Thucydides.** I, II; 1 unit. HELLER.

423. **Aeschylus and Sophocles.** I, II; 1 unit. PERRY.

424. **Euripides.** I, II; 1 unit. TURYN.

425. **Greek Drama: Comedy.** I, II; 1 unit. TURYN.

461. **Greek Archaeology.** Methods and principles of Greek archaeology, as exemplified in the study of pottery, sculpture, architectural remains, coins, and inscriptions. I, II; 1 unit. Prerequisite: One year of ancient history or consent of instructor. Knowledge of Greek not required.

95. **Bibliography and Criticism.** Same as Latin 495. Introduction to the methods and techniques of scholarship. I; ½ unit. OLIVER.

96. **Bibliography and Criticism.** Same as Latin 496. II; ½ unit. OLIVER.

99. **Thesis Research.** Same as Latin 499. Guidance in writing theses for advanced degrees. I, II; 0 to 4 units. HELLER, OLIVER, PERRY, TURYN.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

18. **Elements of Technical Terminology.** Presentation and analysis of Greek and Latin prefixes, suffixes, and root-words basic in the vocabularies of modern science, especially botany, psychology, zoology, and medicine. I, II; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent, or completion of twenty hours of science or architecture. Knowledge of Greek or Latin is not required. HELLER.

91. **Readings in Greek Literature.** Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. I, II; ½ to 1 unit. Prerequisite: Two years of college Greek; consent of instructor. STAFF.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge of French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the degree of Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. At least two of the four required units in Latin must be in courses numbered above 400; the other two units may be chosen in whole or in part from Latin 311, 312, and 391. The required work in education consists of Education 311 and 312 and one unit selected from Education 301, 302, 303, 304. The electives may be in Latin, in Greek, in education, or, in exceptional cases, in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. L. Heller, 138 Lincoln Hall.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered on demand. Consult the departmental office, 138 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is four years of college Latin or equivalent.

400. **Beginning Latin for Graduate Students.** Basic grammar and vocabulary; practice in reading. Intensive course for graduate students who need to use Latin in their research. I; 4 hours. No graduate credit. OLIVER.

401. **Readings in Latin for Graduate Students.** Directed readings, largely in medieval and modern Latin. Designed for graduate students who need to use Latin in their research. II; 4 hours. No graduate credit. Prerequisite: Latin 400 or two years of high school Latin. HELLER.

409. **History of the Latin Language.** I, II; 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language. HELLER.

410. **Vulgar Latin.** I, II; 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language. HELLER.

411. **Latin Epigraphy.** I, II; 1 unit. Prerequisite: Three years of college Latin or equivalent; one year of ancient history. OLIVER.

412. **Latin Elegy.** I, II; 1 unit. OLIVER.

413. **Caesar.** I, II; 1 unit. TURYN.

414. **Lucan.** I, II; 1 unit. OLIVER.

415. **Lucretius.** I, II; 1 unit. PERRY.

416. **Vergil.** I, II; 1 unit. TURYN.

421. **Horace.** I, II; 1 unit. TURYN.

422. **Plautus and Terence.** I, II; 1 unit. TURYN.

423. **Latin Romance.** I, II; 1 unit. PERRY.

425. **Cicero.** I, II; 1 unit. TURYN.

426. **Tacitus.** The *Annales.* I, II; 1 unit. OLIVER.

427. **Roman Satire.** I, II; 1 unit. PERRY.

441. **Latin Paleography.** I, II; 1 unit. OLIVER.

462. **Topography and Monuments of Ancient Rome.** I, II; 1 unit. Prerequisite One year of ancient history or consent of instructor.

495. **Bibliography and Criticism.** Same as Greek 495. Introduction to the methods and techniques of scholarship. I; ½ unit. OLIVER.

496. **Bibliography and Criticism.** Same as Greek 496. II; ½ unit. OLIVER.

499. **Thesis Research.** Same as Greek 499. Guidance in writing theses for advanced degrees. I, II; 0 to 4 units. HELLER, OLIVER, PERRY, TURYN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Caesar and His Background.** Geography, history, and politics of the age of Caesar. Lectures and readings in the sources. Designed especially for the high school teacher. S; ½ unit. Prerequisite: One year of college Latin beyond the level of four years in high school.

311. **Advanced Latin Composition.** Practice in the writing of Latin prose. I; ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major. TURYN.

312. **Advanced Latin Composition.** II; ½ unit. Prerequisite: Latin 311. TURYN.

313. **Oral Latin.** Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Prerequisite: Latin 312 or consent of instructor.

391. **Readings in Latin Literature.** Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Livy, Horace, Vergil, Cicero's *Orations,* Seneca, Ovid, Cicero's *Essays,* Patristic Latin, Medieval Latin. I, II; ½ to 1 unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

COMMUNICATIONS

The graduate program leading to the degree of Doctor of Philosophy in Communications is administered by an interdisciplinary committee appointed by the Dean of the Graduate College. It provides a core program of study in communications and permits advanced specialization in a number of areas: process, content, and effects of the mass media, including their political, social, and economic aspects; advertising; interpersonal communication; psycholinguistics and linguistics.

The program is designed to apply the methods and disciplines of the social sciences, supported by the humanities, fine and applied arts, and natural sciences, to the basic problems of human communication. It is intended for students whose academic and professional experience qualifies them for advanced study in this area and whose plans for careers are such as to make this interdepartmental degree appropriate. Among such careers may be the teaching of communication subjects such as journalism, radio-television, and linguistics; scholarly research on the development, control, and ethics of the mass media, experimental research on public opinion measurement, advertising, communication effects, psycholinguistics, and semantics; executive jobs in government and industry requiring breadth, perspective, and a scholarly background.

Prerequisite to admission to this program is a broad background in the social sciences and humanities. If a student is lacking in the prerequisite background, he may be admitted probationally while he makes up the deficiency, but he may not count these courses among the twenty-four units required for the degree. The applicant is advised that many of the advanced courses have introductory courses as prerequisites. Attention is also called to the general usefulness to the applicant of an introductory course in statistics.

A candidate for the degree of Doctor of Philosophy in Communications must complete at least twenty-four units of graduate work. Programs are individual but must provide both a broad introduction to the field of communications with its related disciplines (requirements 1, 2, and 4, below), and a specialization in a subfield of communications (requirements 3 and 5). A minimum of sixteen units

are taken in course work and eight units in thesis credit. The following are the detailed requirements to be met in the student's course of study.

(1) The Communications proseminar (courses 471 and 472) is required of all students for two units credit.

(2) One unit must be selected from the following courses (Group A): Communications 444, 446, 462, 467, 468, 473, 474, 481, or 372; and one unit from the following courses (Group B): Communications 426, 441, 442, 456, 475, 476, 479, 301, 302, 370, and 373.

(3) The remaining units of course work should contribute to an area of specialization in communications. The following are suggested areas: theory of communications, philosophy of communications, communications policies and structures, public opinion and attitude formation, advertising (illustrated by Group A above); interpersonal communication, psycholinguistics, linguistics, experimental phonetics (illustrated by Group B above). Upon occasion other specializations may be developed subject to the approval of the Committee on Graduate Study in Communications. Of this specialization two units bearing graduate credit must be taken in courses in research methods which are appropriate to the area of specialization; such courses may deal with the philosophical, historical, mathematical, or technical aspects of inquiry and research.

(4) Completion of either a sole minor of four units in a discipline other than communications in courses chosen to complement the student's special field within communications; or a split minor with three units in a discipline other than communications and three units in a field of communications outside the area of concentration. (If the concentration is in Group A, the minor must be in Group B, and *vice versa.*) Courses cross-listed in communications may not be counted toward a minor in a discipline other than communications.

(5) Eight units credit must be earned in Communications 499 by the submission of a satisfactory dissertation.

(6) The language requirements of the Graduate College must be met.

(7) The candidate must pass a preliminary written and oral examination.

(8) The candidate must pass a final oral examination centered on but not restricted to the field of the dissertation.

The student's special adviser is appointed as soon as the student has decided on an area of specialization, but the general adviser must approve the student's program during the first eight units of the student's program.

Minor in Communications

A candidate for the degree of Doctor of Philosophy who wishes to minor in communications should select four, three, or two units (according to the requirements of his major department) from the list below: Communications 471 and 472 are recommended for the student desiring a broad survey of theory and research in this area. Candidates minoring in communications are expected to have a social science background sufficient for such courses as they choose. A student having doubts as to the adequacy of his background should consult the chairman of the administrative committee, who will also advise him as to the desirable combinations and sequences of courses.

Inquiries for further information should be addressed to the chairman of the administrative committee, Professor Dallas W. Smythe, 119 Gregory Hall. A brochure describing the graduate program in communications and the kinds of professional careers for which it gives training may also be obtained from Professor Smythe.

THE INSTITUTE OF COMMUNICATIONS RESEARCH

The Institute is an interdisciplinary group studying problems relating to the communications process and its role in society. Its staff consists of research professors, usually appointed part time in the Institute and part time in related

departments, and graduate student research assistants. The research backgrounds and interests of the staff range from linguistics, through psychology and the other social sciences, to journalism and other disciplines concerned with the mass media. Graduate students in the communications program frequently participate in the research activities of the Institute of Communications Research and have access to the research personnel and facilities of this unit of the College of Journalism and Communications. Inquiries concerning the Institute of Communications Research should be addressed to its director, Professor Charles E. Osgood, 120 Gregory Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in communications may be obtained from the dean of the College of Journalism and Communications, 119 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: D. W. Smythe (Chairman of Committee on Graduate Study in Communications), J. W. Albig, G. Fairbanks, L. S. Hultzén, H. R. Kahane, C. E. Osgood, T. B. Peterson, C. H. Sandage.

Assistant Professors: G. Gerbner, J. W. Jensen, H. S. Maclay, P. H. Tannenbaum.

Lecturer: H. J. Skornia.

COURSES FOR GRADUATES

426. **Psycholinguistics.** Same as Psychology 426. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. Application is made to various problems in communication and the social sciences. I or II; 1 unit. Prerequisite: Six units of graduate work in psychology or consent of instructor. Osgood.

441. **Seminar in the Structure of Literature.** Same as Humanities 441. The study of present-day structural theories in literary criticism, particularly with application of recent linguistic methods. II; 1 unit. Kahane.

442. **Seminar in Phonetics.** Same as Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. I or II; 1 unit. Prerequisite: Consent of instructor. Hultzén.

444. **Seminar in Public Opinion.** Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. I, II; 1 unit. Albig.

446. **Opinion Polling Analysis.** Same as Sociology 446. The study of current polling practices, organizations, and findings; evaluation of results in terms of the prediction and interpretation of social behavior. I, II; 1 unit. Albig.

456. **Psychology of Social Communication.** Same as Psychology 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. I or II; 1 unit. Prerequisite: Psychology 451 or equivalent, or consent of instructor.

462. **Seminar in Radio and Television.** Same as Journalism 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. I; 1 unit. Skornia.

467. **The Political Economy of Communications, I.** Same as Journalism 467. Analysis of theory and problems concerning such social agencies of communication as newspapers, magazines, books, postal service, and telegraph, with special emphasis on their policies and structures. I; 1 unit. Prerequisite: Economics 102 and 103, or 108, or consent of instructor. SMYTHE.

468. **The Political Economy of Communications, II.** Same as Journalism 468. Analysis of theory and problems concerning such social agencies of communication as telephone, radio services (including television), and motion pictures, with special emphasis on their policies and structures. II; 1 unit. Prerequisite: Communications 467. SMYTHE.

471. **Proseminar in Communications, I.** Same as Journalism 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. I; 1 unit. SMYTHE and others.

472. **Proseminar in Communications, II.** Same as Journalism 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. II; 1 unit. OSGOOD and others.

473. **History and Theory of Freedom of the Press.** Same as Journalism 473. Development of the Anglo-American press system; philosophical bases of competing press systems. I; 1 unit. JENSEN.

474. **Government and Mass Communications.** Same as Journalism 474. Current legal, constitutional, and administrative problems of media of mass communications; contemporary issues resulting from the restrictive, regulatory, and supplementary activities of government in the field of mass communications. II; 1 unit. JENSEN.

475. **Experimental Phonetics, I.** Same as Speech 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. I; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

476. **Experimental Phonetics, II.** Same as Speech 475. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. II; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

479. **Seminar in Experimental Phonetics.** Same as Speech 479. Advanced consideration of experimental research in the physiological, acoustical, and psychophysical aspects of speech and hearing. Extensive survey of current literature. S; 1 unit. Prerequisite: Communications 475 and 476, or consent of instructor. FAIRBANKS.

481. **Advanced Advertising Principles.** Same as Journalism 481 and Marketing 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communication.** Same as Journalism 482 and Marketing 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

490. **Research in Special Topics.** Same as Journalism 490. I, II; ½ to 1 unit. Students may register for a total of 2 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** I, II; 1 to 4 units. Students may re-register for a total of

eight units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications and of thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Linguistics.** Same as Humanities 301. An introduction to the science of descriptive linguistics. I; ½ to 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

302. **Comparative Linguistics.** Same as Humanities 302. An introduction to the historical aspects of language. II; ½ to 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences or equivalent. KAHANE.

370. **Language, Culture, and Society.** Same as Anthropology 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. II; ½ or 1 unit. MACLAY.

372. **Social Aspects of Mass Communications.** Same as Journalism 372. Basic principles of social communication by film, radio, television, popular music, and literature; the media as institutions and as the "public arts" of modern society; products, practices, and standards of popular culture in American life. II; ½ unit. GERBNER.

373. **Phonetics and Phonemics.** Same as Speech 373. Methodologies of phonetics, with special application to English; general principles of phonemic interpretation. I or II; ½ to 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Speech 301. HULTZÉN.

392. **Research Methods for Press, Radio, and Television.** Same as Journalism 392. An introduction to relevant research methods and practices for mass media personnel who need to use research as a tool of management and policy, order research, and interpret research. Lectures, readings, and laboratory practice. II; ½ unit. TANNENBAUM.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction, each calling for a somewhat different undergraduate preparation and graduate program. Students majoring in dairy science may select one of these areas of study for the master's or doctor's degree. Students interested in the economics of milk production normally major in the Department of Agricultural Economics. For the Master of Science degree, students may elect to confine their work entirely to the major. If a minor is chosen, it must be in another department. For the Doctor of Philosophy degree, students may select a sole minor in another department, or a first minor and a second minor, the first of which may be in a field closely allied to the area of specialization of the major; the second must be taken in another department. The amount of graduate credit required in each case is dependent upon the specifications of the Graduate College and the department in which the minor is chosen. Students selecting dairy bacteriology or dairy biochemistry as areas of specialization for the major in dairy science should expect and be prepared to elect some branch of chemistry as one of the minors for an advanced degree.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.5.

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. A faculty adviser specifies course requirements and their sequence and directs the research and the preparation of the thesis. Candidates for the degree of Master of Science must complete one-half unit of Dairy Science 490 and two units of Dairy Science 499. For the degree of Doctor of Philosophy, one and eight units, respectively, of these courses are required. Other course requirements depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the degree of Master of Science are expected to complete an acceptable thesis unless conditions warrant waiver of this requirement, which may be done only upon petition to and permission of the Dean of the Graduate College. All students expecting to continue graduate studies should fulfill the thesis requirement for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science is a departmental requirement for the degree of Master of Science.

For a minor in dairy science, students should select a minor adviser in the area of study of their choice and determine with that adviser the specific courses required. For the degree of Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the degree of Doctor of Philosophy, the minimum requirements for a sole minor are four units of dairy science of which two units must be in courses numbered 400 or higher; for a first minor, three units in dairy science; and for a second minor, two units in dairy science.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in dairy science may be obtained from the head of the department, 315 Animal Sciences Laboratory.

GRADUATE TEACHING FACULTY

Professors: G. W. Salisbury (Head of Department), K. E. Gardner, N. L. VanDemark.

Associate Professors: K. A. Kendall, W. O. Nelson, R. W. Touchberry, W. A. Wood.

Assistant Professors: R. E. Brown, J. H. Byers, R. L. Hays, B. L. Larson.

COURSES FOR GRADUATES

402. **The Microbiology and Physiology of Ruminant Nutrition.** The physiological and microbiological aspects of ruminant digestion and their influence on the metabolism of the extraruminal tissues; interpretation of nutritive requirements in terms of rumen microbial activities and evaluation of research techniques. I; ¾ unit. Prerequisite: Bacteriology 300, Chemistry 350, 355, or equivalent. Brown, Nelson.

405. **Economic Milk Production.** II; 1 to 2 units.

408. **Physiology of Lactation.** The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. II; ½ to 2 units. Hays.

411. **Population Genetics and Animal Breeding.** Same as Animal Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. II; 1 unit. Prerequisite: Dairy Science 110 or equivalent. A knowledge of elementary algebra is essential. Touchberry.

430. **Physiology of Mammalian Germ Cells.** A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. II; 1 unit. Prerequisite: Dairy Science 330, Animal Science 406, and Chemistry 350, or consent of instructor. SALISBURY, VANDEMARK.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy 440, Animal Science 440, Horticulture 440, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. JACOB.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy 441, Animal Science 441, Horticulture 441, and Veterinary Medical Science 441. A continuation of Dairy Science 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Dairy Science 440 or equivalent. JACOB.

450. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. I, II; ½ to 2 units. Prerequisite: Ten hours of advanced bacteriology and/or chemistry; consent of instructor. NELSON, WOOD.

453. **Dairy Bacteriology Seminar.** Discussion of current literature and problems in dairy bacteriology. II; ½ unit. NELSON, WOOD.

490. **Dairy Science Seminar.** Current literature relating to various phases of dairy science. I, II; ½ unit. SALISBURY.

493. **Special Problems.** Individual investigations in any phase of dairy science. I, II; ½ to 2 units. BROWN, BYERS, GARDNER, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOOD.

499. **Thesis Research.** I, II; 0 to 4 units. BROWN, BYERS, GARDNER, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOOD.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** I, II; ½ to 1 unit. Prerequisite: Approval of head of department. BROWN, BYERS, GARDNER, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOOD.

305. **Genetics and Animal Improvement.** Same as Animal Science 305. The principles of heredity and their application to the problems of animal improvement. II; ¾ unit. Prerequisite: Dairy Science 110 or equivalent. LASLEY, TOUCHBERRY.

311. **Problems in Dairy Farming.** Dairy farm operation, including field and building arrangement, cropping systems, herd management, sanitary milk production, and farm marketing problems. Lectures, quiz, assigned readings, and term problems. I; ¾ unit. Prerequisite: Dairy Science 100 and 202.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. I; ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. VANDEMARK.

334. **Marketing Dairy Products.** Same as Agricultural Economics 334 and Marketing 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade as-

sociations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5.00. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

350. **Advanced Dairy Bacteriology.** A systematic study of the cultural, physiological, and biochemical properties of microorganisms; the application of principles to problems concerning the microflora of milk, milk products, and the bovine digestive system. I; 1 unit. Prerequisite: Bacteriology 104; Chemistry 122 and 132 or equivalent. NELSON, WOOD.

381. **Dairy Biochemical Laboratory Methods.** Theory and application of dairy biochemical laboratory methods: proximate analysis, spectrophotometry, chromatography, protein separation, microtechniques, micro respiration, and others. II; 1 unit. Prerequisite: Quantitative analysis; organic chemistry; consent of instructor. Biochemistry is recommended. LARSON.

ECONOMICS

The Department of Economics offers graduate work leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy.

The minimum grade-point average for admission to graduate study in economics is 3.5.

Students who wish to make economics their major subject for an advanced degree must have had at least twenty-seven hours of undergraduate work in social science, fifteen of which must have been in economics; the work in economics must include a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite. Students in other departments who wish to take a minor in economics must have had at least twelve hours in social sciences, eight hours of which must have been in economics, consisting of a course in principles of economics and other courses for which the course in principles is a prerequisite. Students who cannot meet these requirements may register for graduate work but, unless specifically exempted because of superior scholarship or for other reasons satisfactory to the adviser in charge, must remove any deficiencies during the first year of residence by taking prescribed courses without graduate credit.

A first-year student whose major is economics must take either Economics 400-401 or 402-403. If a minor is taken outside the department, two units of work are ordinarily required. Undergraduate courses approved for graduate credit may be taken in lieu of graduate courses but not for more than a total credit of two units.

A student who wishes to become a candidate for the Doctor of Philosophy degree with a major in economics must pass a preliminary examination showing (1) a detailed knowledge of economic theory and its history; (2) a detailed knowledge of certain special fields of economics or allied fields, the number and selection of which is to be determined by the adviser in consultation with the student; and (3) a general acquaintance with the subject matter and bibliography of other branches of economics. In the work offered in some related field outside the department, the student is expected to satisfy the examiners as to his proficiency in that subject.

A student who chooses economics as a minor for the Doctor of Philosophy degree must take at least two units of work in this department.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in economics may be obtained from the chairman of the department, 226 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professors: J. F. Bell (Chairman of Department), H. K. Allen, V L. Bassie, H. Brems, W. E. Chalmers, J. F. Due, R. Ferber, D. P. Flanders, H. M. Gray, R. W. Harbeson, D. L. Kemmerer, D. P. Locklin, E. B. McNatt, W. H. McPherson, W. A. Neiswanger, J. B. Parrish.

Associate Professors: Grace Beckett, R. Brandis, F. B. Haworth, D. R. Hodgman, G. Kleiner, J. L. McConnell, D. W. Paden, Janet L. Weston, L. E. Wagner.

Assistant Professors: C. C. Jones, F. W. Kohlmeyer, W. W. McMahon, D. M. Soule, P. J. Wells, T. E. Yancey.

COURSES FOR GRADUATES

400. **General Economic Theory.** A preliminary survey of business, labor, government, monetary, and other institutional aspects of economics, followed by a more extended analysis of theoretical economics and the application of this theory to some of the problems raised in the preliminary survey. Intended for students whose minor is economics and other students who have only the minimum preparation for graduate study in economics. I; 1 unit. Prerequisite: Economics 102 and 103, or 108. Flanders.

401. **General Economic Theory** A preliminary survey of business, labor, government, monetary, and other institutional aspects of economics, followed by a more extended analysis of theoretical economics and the application of this theory to some of the problems raised in the preliminary survey. Intended for students whose minor is economics and other students who have only the minimum preparation for graduate study in economics. II; 1 unit. Prerequisite: Economics 102 and 103, or 108. Flanders.

402. **Economic Theory.** From the fundamentals laid by classical and neo-classical writers, this course develops modern micro-economic and macro-economic theory: demand and cost, market forms, price policy, non-price competition, general equilibrium theory, and input-output analysis. I; 1 unit. Prerequisite: Twenty-seven hours of undergraduate work in social sciences, fifteen of which must have been in economics; the work in economics must include a course in the principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite. Brems.

403. **Economic Theory.** From the fundamentals laid by classical and neo-classical writers, this course develops modern micro-economic and macro-economic theory: employment, wage, interest and monetary theory, the theory of investment, the theory of consumption, the theory of steady advance, and the theory of welfare. II; 1 unit. Prerequisite: Twenty-seven hours of undergraduate work in social sciences, fifteen of which must have been in economics; the work in economics must include a course in the principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite. Brems.

404. **Theory of Aggregate Income.** A comprehensive introduction to the theory of income and employment with emphasis upon fluctuation and growth. I, II; 1 unit. Prerequisite: Graduate standing. Paden.

406. **A History of Economic Thought.** Development of economic thought from early times to the present. I; 1 unit. Bell.

407. **A History of Economic Thought.** Development of economic thought from early times to the present. II; 1 unit. Bell.

410. **Comparative Economic Systems.** The economics of capitalism, socialism, communism, and fascism. I; 1 unit. McConnell.

411. **Economics of Underdeveloped Countries.** Economic history, population and labor, national income, consumption and investment, agriculture, and land tenure systems as they relate to national and international plans for economic development of the backward areas. Emphasis on adaptation of standard tools of economic analysis to problems of development. Case studies of Brazil, India, China, and Japan. Special attention is given to cultural pre-conditions for economic progress. II; 1 unit. Prerequisite: Economics 102 and 103, or 108. McConnell.

414. **Public Finance.** An analysis of the economics of public expenditures, administration of public funds, intergovernmental fiscal relations, non-tax revenues, public borrowing, debt management, and fiscal policy. I; 1 unit. Prerequisite: Six hours of economics. Allen, Due.

415. **Economics of Taxation.** An analysis of the economics of taxation, with respect to distribution of tax burden, incidence of taxation, and the place in the tax system of the major taxes, particularly the personal and corporation income, sales and excise, property, and death taxes. II; 1 unit. Prerequisite: Six hours of economics. Allen, Due.

420. **Monetary Theory and History.** A critical examination of monetary theories and their neoclassical antecedents. Among the topics considered are the rate of interest, the level of income, the level of employment, changes in the general level of prices, and the relationship of monetary and fiscal policy. I; 1 unit. Prerequisite: A course in income or employment theory, or consent of instructor. Hodgman.

428. **International Economics and Finance.** Analysis of international monetary standards; of their effects on domestic income levels, finance, and central bank problems. I; 1 unit. Kleiner.

429. **International Economics and Finance.** Governmental policies designed to maximize domestic welfare through international exchange of goods and services and through international investment. II; 1 unit. Kleiner.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 336. I; 1 unit. Kemmerer.

437. **Research in American Economic History.** Readings on special problems in primary sources, monographs, and learned journals; training in the use of bibliographical materials and in principles of historical method and research, and the application of economic principles to the study of American economic history. Preparation of a short term paper based exclusively on primary sources. II; 1 unit. Prerequisite: Economics 336 or 436, or equivalent, and a course in economic principles, or consent of instructor. Kemmerer.

438. **Economic History of Europe.** The major lines of development since 1450; comparative study of forces and institutions inimical or favorable to growth; selected readings on organization of economic activity, role of governments and the entrepreneur, commercial policy, monetary systems, land tenure, process of capital formation, and industrialization, etc. II; 1 unit. Prerequisite: Consent of instructor.

440. **Labor Economics.** Same as Labor and Industrial Relations 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. I; 1 unit. Prerequisite: Six hours of economics. McNatt.

441. **Labor Economics.** Same as Labor and Industrial Relations 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. II; 1 unit. Prerequisite: Six hours of economics. McNatt.

442. **Problems and Practices in Collective Bargaining.** Same as Labor and Industrial Relations 442. Seminar in the methods and techniques of collective bargaining in the negotiation of the labor contract; nature and significance of labor agreements; union, management, and public interests in major contract provisions. I; 1 unit. Prerequisite: Consent of instructor. Chalmers.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Labor and Industrial Relations 443. Seminar in the techniques of labor contract administration; comparative study of grievance procedure operation; analysis of conciliation, fact-finding, and arbitration procedures, including case studies of arbitration awards. II; 1 unit. Prerequisite: Consent of instructor. McPherson.

444. **The Labor Market.** Same as Labor and Industrial Relations 444. Basic labor force concepts and measurement; economic theory of market operation and contemporary research; long and short run changes in labor force size, composition, mobility, and participation rates, wartime problems of mobilizing labor resources; international aspects, industrial and military, of differential population and labor force growth; public policy and market operations. I; 1 unit. Prerequisite: Six hours of economics. Parrish.

445. **The Labor Market.** Same as Labor and Industrial Relations 445. Concepts, sources of materials, methods of analysis, nature of labor supply, nature of labor demand and recruitment; determinants of interplant occupational mobility with emphasis on the wage structure and the role of wages in allocation of labor supply; adjustment to technological change; problems of the older worker; development of market policy by unions and management; development of public policy including employment service and anti-discrimination programs. II; 1 unit. Prerequisite: Six hours of economics. Parrish.

447. **Labor Union Organization and Administration.** Same as Labor and Industrial Relations 447. Analysis of the structure and government of the modern American trade union movement with particular reference to the relation between organization and function. Problems relating to the function and execution of economic policies, the maintenance of unity and discipline, the adjustment of jurisdictional conflicts, and the observance of agreements are examined and appraised. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. Chalmers, Garman.

470. **Economic Statistics.** Basic concepts and methods of statistical analysis as applied in economics and business. I; 1 unit. Prerequisite: Consent of instructor. Neiswanger.

471. **Economic Statistics.** Methods of analysis, problems of aggregation and index numbers, nature of economic time series and problems of analysis; input-output analysis and special problems of functional analysis in economics. II; 1 unit. Prerequisite: Economics 470 or nine hours of applied or theoretical statistics. Neiswanger.

472. **Econometrics.** Same as Mathematics 472. Application of the principles of mathematical statistics to estimation of economic relationships. II; 1 unit. Prerequisite: Mathematics 363; consent of instructor. Yancey.

473. **Economic Forecasting.** Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of

judgment in evaluating current information; selecting critical factors, and appraising the validity of analytical techniques. II; 1 unit. Prerequisite: One year of statistics. BASSIE.

480. **Seminar in the Relations of Government and Business.** Problems in the relations of government and business. Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. I; 1 unit. GRAY.

481. **Seminar in the Relations of Government and Business.** Problems in the relations of government and business. Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. II; 1 unit. GRAY.

484. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. I; 1 unit. LOCKLIN.

485. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. II; 1 unit. LOCKLIN.

488. **Government Regulation of Economic Activity.** A critical economic appraisal of the objectives and results of government policy and practice in controlling economic activity. I, II; 1 unit.

490. **Individual Study and Research.** Directed reading and research. I, II; ½ to 1 unit. STAFF.

499. **Thesis Research.** Required of all students writing master's and doctor's theses in economics. I, II; 0 to 4 units. Master's theses, FLANDERS; doctor's theses, BELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Intermediate Economic Theory and Analysis.** A development of the leading theories and analyses of value and distribution. Problems and policies of price determination of both the firm and the industry and factor pricing are presented at the intermediate level of analysis. I, II; ½ unit. Prerequisite: Economics 102 and 103, or 108 and 109. BELL, DUE.

301. **Monetary and Employment Theory.** Monetary theory including various versions of the quantity theory of money; the modern theory of the determination of the level of income and employment; theories of money and interest; fiscal and monetary policy; criteria, proposals, critique. I, II; ½ unit. Prerequisite: Finance 250. WELLS.

304. **Mathematical Analysis in Economics.** Designed to acquaint the student with rudimentary mathematical techniques and their application to economic analysis. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108 and 109; Mathematics 111 or 112. BREMS.

306. **History of Economic Thought.** A study of the development of economics. Contributions of schools of thought and individual writers are examined as they influenced economic thought and national policy. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. BELL.

312. **The Soviet Economy.** Analytical survey of Soviet economic development; structure and performance of the economy; problems of planning and control. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HODGMAN.

313. **Economics of Consumption.** Analysis of population, personal income distribution, consumption theories, savings and price movements; aggregate consumption expenditures and consumer choice; applications in the areas of laws affecting consumers, credit and tax policies. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MILLICAN.

326. Theories and Policies of International Commerce. Analysis of international trade theories, classical and recent; international commercial policies, past and current; economic development in selected world regions; international commercial agreements and conferences; foreign trade policy of the United States. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. BECKETT.

328. Latin-American Economic Problems. Economic problems of commerce, finance, transportation, mining, agriculture, and industry in Latin America; Latin-American and international economic relationships. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108, or consent of instructor. BECKETT.

329. Commerce and Industry in South America. A study of the economic development of the countries of South America. Specialization, characteristics of economic activity, growth of manufacturing; foreign exchange mechanism, balance of payments adjustment, exporting and importing. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; consent of instructor. BECKETT.

335. American Financial History. American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banks and of other financial institutions, and the financing of major wars. II; ½ to 1 unit. Prerequisite: Finance 250. KEMMERER.

336. American Economic History. Westward movement; growth of industry, agriculture, commerce, finance, transportation, trust movement, and labor since 1790. I, II; ½ to 1 unit. KEMMERER.

337. Economic History of American Agriculture. Same as Agricultural Economics 337 and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. Graduate students who take this course for one unit credit are required to do extra work. The student writes a scholarly paper on some approved topic in agricultural history. II; ½ or 1 unit. Prerequisite: A college level course in basic economics or American history. JONES.

342. Economics of Social Security. Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MCNATT.

344. The Law and Labor. Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; Economics 240. MCNATT.

346. Foreign Labor Movements. Same as Labor and Industrial Relations 346. Analysis of the history, organization, economic policies, political programs and domestic, international, and contemporary influence of the labor movements of Great Britain, Sweden, Germany, France, Latin America, and Russia. I; ½ to 1 unit. Prerequisite: Economics 240. CHALMERS.

370. Applied Statistical Analysis. A general course in statistical methods applied to the subject matter fields of the College of Commerce and Business Administration. Intended principally for those students who have entered or intend to enter a program of graduate study and whose training in the basic statistical methods employed in these disciplines is inadequate. Credit is not given for Economics 370 in addition to Economics 271. I; 1 unit. Prerequisite: Two semesters of principles of economics; six additional hours in economics or consent of instructor. NEISWANGER.

371. **Applied Problems in Sampling.** Design of various types of samples useful in economic and business research; cost limitations and design of samples; sources of bias and sampling methods; interpretation of results; practical experience in conducting a complete sampling survey as a class project. II; ½ unit. Prerequisite: Economics 170 or a similar introductory course in statistics.

372. **Operations Research.** Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of probability theory, linear programming, statistical management controls, queuing theory; business policy and statistical decisions. I; ½ to 1 unit. Prerequisite: Economics 170 and Management 101, or consent of instructor.

374. **National Income and Business Forecasting.** The development of the national economic accounts and their use in forecasting business conditions for the economy as a whole and for the individual firm. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. PADEN.

375. **Business Cycles and Economic Growth.** An analysis of the causes of economic instability, the requirements for economic growth in the national economy, and a consideration of public policy relating to instability and growth. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. PADEN.

379. **Elements of Econometrics.** The formulation of hypotheses concerning economic relationships, different types of models, the identification and statistical testing of relations, and the efficient computation of numerial estimates. II; ½ to 1 unit. Prerequisite: One year each of statistics and economic theory; consent of instructor. YANCEY.

382. **Economics of Highway Transportation.** The organization, economic characteristics, and regulation of commercial motor transportation; development and management of the highway network; highway finance, with special attention to problems of user charges and cost allocation; the transportation problems of urban areas. I; ½ unit. Prerequisite: Economics 102 and 103, or 108; junior standing. HARBESON.

384. **Economics of Transportation.** Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HARBESON, LOCKLIN.

385. **Economic Problems of Commercial Air Transport.** Study of air transport with particular reference to questions of public policy, system of regulation, and regulatory policy. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. LOCKLIN.

386. **Current Transportation Problems.** An analytical and critical study of selected problems of current interest in transportation. II; ½ to 1 unit. Prerequisite: Economics 384. HARBESON.

389. **Industrial Competition and Monopoly.** The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership as alternatives to the antitrust approach. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HARBESON.

Note: See also Business Administration 373, Electronic Data Processing for Business.

EDUCATION

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology, elementary school teaching, guidance and counseling (including rehabilitation counseling), history and philosophy of education, home economics education, industrial education, research methods, secondary school teaching, or school psychology.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher, and undergraduate preparation appropriate to advanced study in the chosen major.

Degree of Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College pertaining to admission, registration, degree requirements, grades, residence, majors and minors, foreign language, and theses (see pages 15-23), the following regulations apply to programs leading to the degree of Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of no more than two units (Education 499), is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required, and may be demonstrated either by satisfactory grades in required courses or by satisfactory completion of proficiency examinations on those courses. Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required.

Degree of Master of Science in the Education of the Deaf. One of the following prerequisites is necessary for admission: (1) a bachelor's degree in elementary or special education (other than education of the deaf), or (2) a bachelor's degree in education of the deaf from an accredited training center for teachers of the deaf.

Candidates for this degree must earn a minimum of eight units as follows:

(1) Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required.

(2) For those students qualifying under prerequisite (1), Education 417, one unit; Education 319, one or one and one-half units; Education 320, one to two units; Speech 301, one-half unit; Speech 395, one-half unit; and Speech 385, one-half unit, are required. For those students qualifying under prerequisite (2), Education 418, one unit, and Education 449, one unit, are required.

(3) Elective courses should be chosen from Education 381, 412, 425, 426, 430, 440, 456, 460; Psychology 443, 461; Speech 375, 388, 488, 489.

The advisers for candidates for this degree are Professors S. A. Kirk, J. J. Gallagher, and Herbert Goldstein, 1003 West Nevada Street.

Degree of Master of Science in the Education of Mentally Handicapped Children. The following are required for admission: Courses sufficient to meet the requirements for an Illinois Teacher's Certificate and Education 220, 231, and Speech 208.

Candidates for this degree must earn a minimum of eight units as follows:

(1) Required courses: Education 311, 312, 322, 323, 417, 426, and two courses chosen from Education 301, 302, 303, and 304.

(2) Elective courses chosen from Education 390, 411, 412, 433; Psychology 438, 406, 411, 445, 461, 467, 493, 494; Speech 385, 388.

The advisers for candidates for this degree are Professors S. A. Kirk, J. J. Gallagher, and H. Goldstein, 1003 West Nevada Street.

Degree of Doctor of Philosophy. A student who wishes to become a candidate for the degree of Doctor of Philosophy with a major in education must (1) have met the academic requirements for the degree of Master of Arts or Master of

Science in Education and (2) have written a thesis. Applicants for admission should present credentials well in advance of the date for their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the student is accepted by an adviser.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Degree of Master of Education.

Admission. In addition to general requirements, the credit presented for admission must include sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

Residence. At least four units must be earned while the student is in residence on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

Program. Each candidate for the Master of Education degree works under the direction of a faculty adviser who helps him plan the program of study he will follow. This program must total at least eight units of course work, including four units in education. Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required, except that students who pass proficiency examinations in these courses are excused from this requirement.

There may be one or two minors with a maximum of four units credit. In general, candidates for the Master of Education degree are expected to take at least two units in fields other than education. This provision is especially applicable to students in secondary education. The general requirements governing minors apply except that courses at the 200 level may be recognized for minor credit. Registration for credit in 200-numbered courses is subject to prior approval of the Dean of the Graduate College. Credit is computed at the rate of one-fourth unit for each semester hour, with two units as the maximum allowed for credit in 200-numbered courses. Credit earned in such courses can not be counted toward requirements for the degrees of Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Advanced Certificate in Education.

Admission. A master's degree from an accredited institution, plus a minimum of two years professional employment in education with a record of successful performance, constitutes the minimum requirement for admission.

Residence. The residence requirement for the Advanced Certificate is similar to that for the Master of Education degree.

Program. The Advanced Certificate in Education requires the satisfactory completion of a year of specialized professional study. Of the eight units of course work required at least four must be in courses at the 400 level. Students who have not previously taken Education 311 and 312, or equivalents, are required to take these courses or pass proficiency examinations on them. A similar provision applies with respect to two courses chosen from Education 301, 302, 303, and 304. Course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education degree. The program that a student proposes to follow must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted a

meeting requirements for the Doctor of Education or the Doctor of Philosophy degrees.

Degree of Doctor of Education. Programs leading to the degree of Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

Admission. A candidate for admission must hold a master's degree from an accredited institution. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

Applicants for admission should present credentials well in advance of the date for their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the student is accepted by an adviser.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

Residence. Minimum residence requirements are (a) two consecutive semesters during each of which a minimum of three units of work is successfully completed or (b) one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. A minimum of sixteen units of course work beyond requirements for the master's degree is required. Extramural course work may not be included in this sixteen-unit requirement. A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the degree of Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. A minimum of ten units must be earned in courses taken at Urbana.

Education 410, 415, and 496 are required (note prerequisites).

A preliminary examination must be passed prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his admission before he may enter the preliminary examination. The preliminary examination is given by a committee appointed by the Dean of the Graduate College. Part of this examination may be written. Part of it must be oral.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations.

The thesis required for the degree of Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis titles and the preparation, submission, and publication of theses must be met.

A final oral examination is held at least two weeks prior to the date the degree is conferred. The examination committee is appointed by the Dean of the Graduate College. The final examination is primarily concerned with the thesis, but also extends over the whole field of the candidate's study. It is designed to determine whether or not the candidate has a thorough and mature understanding of the field of education as a whole.

Degree of Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 211.

GRADUATE STUDY IN SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy degree. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an interne. After an applicant is admitted as a graduate student in the department of his choice, his acceptance and his work in this program are subject to review by the Joint Committee on School Psychology, representing the College of Education and the Department of Psychology.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in education may be obtained from Professor F. H. Finch, 105 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: B. L. Dodds (Dean of the College of Education), C. M. Allen, A. W. Anderson, D. P. Ausubel, F. P. Barnes, T. E. Benner, G. M. Blair, R. B. Browne, R. W. Burnett, L. J. Cronbach, J. J. DeBoer, G. P. Deyoe, B. N. Evans, F. H. Finch, N. L. Gage, C. R. Griffith, H. M. Hamlin, H. C. Hand, J. T. Hastings, K. B. Henderson, R. S. Jones, M. R. Karnes, W. V. Kaulfers, G. C. Kettelkamp, S. A. Kirk, C. G. Knapp, W. P. McLure, P. V. Miller, T. E. Newland, C. W. Odell, M. M. Ohlsen, L. J. Phipps, E. F. Potthoff, C. W. Sanford, H. A. Schultz, J. H. Shores, R. H. Simpson, B. O. Smith, W. O. Stanley, Celia B. Stendler, M. R. Sumption, J. L. Trump, Letitia Walsh.

Associate Professors: J. M. Atkin, G. C. Finlay, G. J. Froehlich, J. J. Gallagher, N. E. Gronlund, C. E. Johnson, W. M. Lifton, J. E. McGill, F. McMurray, L. E. Metcalf, W. J. Moore, C. H. Patterson, R. E. Pingry, F. C. Proff, R. A. Tinkham, R. J Young.

Assistant Professors: H. Goldstein, H. Kaiser, A. P. Whitney.

COURSES FOR GRADUATES

400. Problems of Educational Theory. Analysis of the kinds of problems encountered in constructing an educational theory, and of relations between educational theory and other disciplines, especially philosophy and the social sciences. I; 1 unit. Prerequisite: Education 301. McMurray.

401. Modern Theories of Education. A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. II; 1 unit Stanley.

402. **Educational Movements in the Twentieth Century.** An historical study of significant educational trends during the past sixty years, with special reference to their influence on American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and of efforts to solve the problems since 1900. I; 1 unit. Prerequisite: Education 300, or 302, or 403, or consent of instructor. ANDERSON.

403. **The Historical Foundations of American Educational Thought.** A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. II; 1 unit. Prerequisite: Education 300 or 302, or consent of instructor. ANDERSON.

404. **Seminar in Educational Classics.** Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. II; 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. BROUDY.

405. **Foundations of Group Methods.** A critical study of the ethical, social-psychological, and methodological ideas and problems underlying currently proposed methods for the management and improvement of groups and for training leadership in using these methods, with special attention to the use of such methods in educational settings. The work includes student projects in the management and improvement of educational and action groups. I; 1 unit. Prerequisite: Education 311 and 312; two of the following: Education 301, 302, 303, 304. GRONLUND, MILLER.

406. **Seminar in the History of Education.** Intensive group study of a small number of selected problems to assist individual students to develop understanding of and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. II; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. ANDERSON.

407. **Logical Foundations of Methods.** A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment, and knowing, examined from the standpoint of recent developments in pragmatism. II; 1 unit. Prerequisite: Consent of instructor. MCMURRAY.

408. **Advanced Philosophy of Education.** An examination of philosophical concepts and issues most closely related to problems in education. Includes readings in the major philosophical writings of John Dewey as well as in other writings representing the more significant current philosophical viewpoints opposed to Dewey's outlook. I; 1 unit. Prerequisite: Advanced graduate standing; consent of instructor. BROUDY, STANLEY.

409. **Advanced Philosophy of Education.** Continuation of Education 408. II; 1 unit. Prerequisite: Education 408. BROUDY, STANLEY.

410. **Seminar in Theories of Educational and Social Change.** Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational

leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. I, II; 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in Education. BROUDY, SMITH, STANLEY.

411. **Psychology of Adolescence for Teachers.** The psychological significance of adolescence, its biological and social foundation, and its implications for education. I, II; 1 unit. Prerequisite: Education 311 and 312. AUSUBEL, BLAIR.

412. **Advanced Child Development for Students of Education.** A consideration of the nature of the child and his development during the pre-school and elementary school years, with emphasis on development as a process of social learning; and interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. I, II; 1 unit. Prerequisite: Education 311 and 312. AUSUBEL, STENDLER.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. II; 1 unit. Prerequisite: Education 311 and 312. GAGE, SIMPSON.

414. **The Psychology of College Teaching.** Designed particularly for graduate students minoring in education or preparing for college teaching. Psycho-educational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction, analysis and use of test results and resource materials in this field. I; 1 unit. Prerequisite: A course in psychology; consent of instructor. SIMPSON.

415. **Psychological Theories Applied to Education.** An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. I, II; 1 unit. Prerequisite: Education 311 and 312; Education 411 or 412; candidacy for Ed.D. or Ph.D. in Education. BLAIR.

416. **Problems in Mental Deficiency.** An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis; social, medical, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, anthropology, and psychology to educational theory and practice with reference to the mentally deficient. I; 1 unit. Prerequisite: Education 322 or 323, or consent of instructor. KIRK.

417. **Psycho-educational Problems of Exceptional Children.** A course for teachers, elementary school supervisors, principals, and superintendents, and for supervisors of special education programs. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children, consideration of the special school provisions needed for their education and development, including the social and educational background of special education programs, the problems of selection of children for special education, teaching procedures, buildings and equipment needed in the programs, legal bases for such programs, financing, and administration. I, II; 1 unit. Prerequisite: Sixteen hours of psychology and/or education or consent of instructor. KIRK, NEWLAND.

418. **Problems in Communication for the Deaf.** An advanced course in the problems of communications used by the deaf, including the learning of language

reading, speech, and speech reading. Consideration is given to the various methods that are used in the teaching of these basic skills to deaf children and the psychological principles underlying the methods. A critical analysis is made of each topic considered. II; 1 unit. Prerequisite: Education 319 and 320, or equivalent.

419. **Clinical Educational Diagnosis.** A clinical course in the diagnosis of educational disabilities, including reading, spelling, and arithmetic. Practice in the use of diagnostic instruments, interpretation of results, and case studies, with recommended remediation, are emphasized. II; 1 unit. Prerequisite: Education 311 and 312; Psychology 443. KIRK.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, and of the somatopsychological significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed on different groups of handicapped children and adults by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. The implications of somatopsychological findings and theories for current educational programs for the handicapped are analyzed. II; 1 unit. Prerequisite: Education 117 and 312, or consent of instructor. NEWLAND.

422. **Basic Principles of Counseling.** Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. I, II; 1 unit. Prerequisite: Education 311 and 312. LIFTON, PROFF.

423. **The Use of Tests in Guidance.** Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. II; 1 unit. Prerequisite: Education 392. HASTINGS, PROFF.

24. **Case Analysis in Guidance.** The nature, synthesis, and use of case data for guidance purposes. Students develop skills in solving typical counseling problems through role playing and other laboratory experiences. II; 1 unit. Prerequisite: Education 422 and 423; consent of instructor. LIFTON, PROFF.

25. **Principles of Guidance.** For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. Students who have taken Education 325 are not allowed credit for Education 425. I, II; 1 unit. LIFTON, OHLSEN, PROFF.

26. **Diagnostic and Remedial Programs of the School.** A study of remedial programs in reading, spelling, English, arithmetic, handwriting, and content subjects. I, II; 1 unit. WHITNEY.

27. **Principles and Techniques of Group Guidance.** A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. II; 1 unit. Prerequisite: Education 311, 312, 422, 423, and either 325 or 425; or consent of instructor. LIFTON, OHLSEN.

8. **The Analysis and Use of Occupational Information in Guidance Programs.** Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. I; 1 unit. Prerequisite: Education 325 or 425, or consent of instructor. OHLSEN, SHOEMAKER.

429. **Field Instruction in Counseling.** Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. I, II; 1 or 2 units. Prerequisite: Education 422 and 424 (with consent of instructor, registration in Education 424 may be concurrent). FINCH, LIFTON, OHLSEN, PATTERSON, PROFF.

430. **Elementary School Organization and Administration.** Intended primarily for elementary school principals and for those who are preparing for the principalship. Such topics as the following are considered: present status of the elementary school principal; classification and promotion of pupils; school records; report cards; plans for student participation in self-government; school-community relationships. II; 1 unit. Prerequisite: Education 431 and 439. BARNES, MILLER.

431. **Elementary School Classroom Programs.** An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. I, II; 1 unit. MOORE, STENDLER.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered in the fields of reading and the language arts, social studies, elementary science, and arithmetic. I, II; 1 unit. Prerequisite: Education 431; for the section in reading and the language arts, Education 336, or a course in the teaching of reading or language arts, or consent of instructor; for the section in elementary science, Education 335 and two years of college science, or consent of instructor. ATKIN, JOHNSON, MOORE, SHORES.

434. **Programs in Early Childhood Education.** An advanced course intended primarily for teachers and supervisors of younger children, ages three to eight. Presents a review and analysis of research findings, experimentation, and current trends in curriculum organization, procedures, and materials essential to developing classroom programs for children. S; 1 unit. Prerequisite: Education 431. MCGILL.

437. **Methods of Child Study.** A study of ways in which teachers can evaluate child behavior and development. Particular emphasis is placed on classroom application. Instruction and practice in the use and interpretation of observations, anecdote records, rating scales, interviews, achievement tests, intelligence tests, questionnaires, sociometric and projective techniques. II; 1 unit. Prerequisite: Education 312 or consent of instructor.

438. **Supervision of the Elementary School.** Designed for present and prospective supervisors in elementary schools. Considers the purposes of supervision in the context of a democratic theory of learning and teaching. The use of teachers' meetings and of individual supervisory techniques are given special attention. I; 1 unit. Prerequisite: Education 431 and 439. BARNES.

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. I, II; 1 unit. HAND, SHORES.

440. **Administration and Supervision of Junior and Senior High Schools.** Discussion of practical problems; functions of the principal; teacher participation;

personnel records, marks, failures, and promotions; administration and supervision of the curriculum, of guidance programs, of extracurricular activities, and of housing and building programs. I, II; 1 unit. Prerequisite: Education 460 or consent of instructor. ALLEN, TRUMP.

441. **Theory and Practice of Teaching in the Secondary School.** An analysis of teaching from the standpoint of social, psychological, linguistic, and logical factors involved in the teaching of content subjects. Recent developments in linguistic analysis, philosophical analysis, and in the psychology of perception are applied to selected problems of secondary school teaching. Lectures and discussion supplemented by observation of classroom activities. II; 1 unit. Prerequisite: Education 301, 311, and 312. HENDERSON, SMITH.

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. II; 1 unit. YOUNG.

447. **Seminar in Rehabilitation Counseling.** Problems of rehabilitation, including problems associated with specific physical and mental disabilities. Critical examination of literature pertaining to rehabilitation, with emphasis on recent publications. May be repeated for a maximum of one unit. I, II; ½ unit. Prerequisite: Education 326 and 442. PATTERSON.

448. **Adult Education.** Development and status of adult education; discovering needs for adult education; policies, organization, administration, finance; planning programs and courses; methods and materials; the literature of adult education; research in adult education. Systematic study of individual problems supplements class work. II; 1 unit. HAMLIN.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. I, II; ½ to 1 unit. No more than two units in Education 449 may be offered toward an advanced degree except by special consent of the Dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. II; 1 unit. WALSH.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. I; 1 unit. WALSH.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. II; 1 unit. WALSH.

455. **Theories of Art Education.** A study of the major theories of art education and an analysis of the most significant research in the field. Emphasis is given to a critical evaluation of theory and research and to the application of such studies to current problems in art education in the public schools. S; 1 unit. Prerequisite: Education 337 or 456, or consent of instructor. LANSING, SCHULTZ.

456. **Curriculum Problems and Trends in Specialized Fields of Secondary Education.** Sections are usually offered in the fields of art education, business education, English, home economics, mathematics, foreign languages, science, social studies, common learnings. Designed to develop an understanding of

the function of a specific field of special interest in general education. Applies principles of curriculum construction to the special field. Introduces the student to significant problems, points of view, and trends in the field concerned. Acquaints him with significant research relating to organization, content, and techniques in the fields in question. Students are limited to registration in any two sections in addition to the section on common learnings. I, II; 1 unit. Prerequisite: Education 439. BURNETT, DEBOER, HAND, HENDERSON, KAULFERS, KNAPP, METCALF, SCHULTZ, WALSH.

458. **Foundations of Aesthetic Education.** A philosophical approach to the problems of teaching for appreciation in formal education. Appraisal of the status of aesthetic education, its nature and function, and its relation to other types of education are the major areas to be investigated. Prerequisite: Consent of instructor. I; 1 unit. BROUDY.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of business, English, home economics, physical education, mathematics, science, social studies, and common learnings education. Broader areas of emphasis, within which students may work, are extra-class activities, conservation, consumer education, family living, guidance, health, inter-group relations, labor-management relations, and public opinion and propaganda. S; 1 to 2 units. STAFF.

460. **Public Control and Administration of Education.** A course to provide the basic common understanding of theory and practice in operation and control of schools useful to teachers and other citizens. The course serves as an introductory course for prospective administrative officers and supervisors. Not open to experienced administrators nor to any students who have taken any of the following courses (or equivalents): Education 430, 440, 461, 462, 464, 465, 466. I, II; 1 unit. BENNER, MILLER, ODELL.

461. **School Finance.** Designed for advanced graduate study of technical problems in school finance. A critical analysis of emerging patterns of financial support in various states, effect of taxation systems on support patterns, emerging controls and structural features as related to finance, the technology of finance distribution patterns for drafting legislation. Review of research on school finance, a critical analysis of theory of school finance, and introduction to techniques of appraising the influence of financial support upon educational returns. I; 1 unit. Prerequisite: Education 460. MCLURE.

462. **Public School Business Management.** Designed for advanced graduate study of business management of local school systems. Emphasis is on the process of operation through first-hand acquaintance with budget making and execution; management of internal accounts; development of effective record systems; purchase, distribution, and management of supplies; operation and maintenance of school plants; management of auxiliary services such as transportation, cafeterias, health; and general office management. II; 1 unit. Prerequisite: Education 460. MCLURE, MILLER.

464. **Current Problems in School Administration.** Designed to give direct help on local problems, to serve as a refresher course, and to bring the administrator up to date on recent developments in school administration. Open only to students currently employed as school administrators. S; 1 to 2 units. STAFF.

465. **Public School Finance and Business Administration.** The theory and practice of financing public education in the United States; development of guiding principles in educational finance, trends and needs in state and federal participation in school support, and local operational finance. Not open to students who have completed Education 461 or 462. II; 1 unit. Prerequisite: Education 460. MCLURE, MILLER.

466. **Administrative Leadership.** Considers the generalized procedures (based on principles underlying democratic leadership drawn from public and business administration, philosophy, psychology, social psychology, and sociology) by which the administrator may work with and through people to develop and operate effective educational programs in public school systems. II; 1 unit. Prerequisite: Education 405 and 460 or equivalent course work or experience. MILLER.

467. **The American College.** Development of the American college and university, public and private; conflicting theories; present trends. II; 1 unit. BENNER.

468. **Public Relations of the Schools.** Study of the interrelationships between the lay community and the schools. Appraisal of procedures, actual or proposed, for the improvement of these relationships. I, II; 1 unit. BENNER.

469. **Legal Basis of School Administration.** The legal rights, privileges, responsibilities, immunities, and authority of pupils, parents, teachers, administrators, and school board members in relation to the school. I; 1 unit. SUMPTION.

471. **Policy and Policy Making for Public School Education in Agriculture.** Local, state, and national policies for agricultural education in the public schools; organizing and conducting policy making; desirable policies. Open to school administrators as well as teachers of agriculture. I; ½ unit. Prerequisite: Agricultural Education 276 and 277. Open to school administrators without prerequisite. HAMLIN.

472. **Course Planning and Teaching Procedures in Vocational Agriculture.** Gathering data essential in course planning, constructing course plans, developing resource units, teaching procedures and instructional aids. I; ½ unit. Prerequisite: Agricultural Education 276 and 277. DEYOE.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, adult education in the public schools, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. II; ½ unit. Prerequisite: Agricultural Education 276 and 277. HAMLIN.

474. **Supervised Farming in Vocational Agriculture.** Importance and meaning of supervised farming; evaluation of supervised farming; relation to establishment in farming; selecting and planning farming programs; records; related instruction; supervision; nature of supervised farming for students in day-school, young farmers, and adult farmers classes. I, II; ½ unit. Prerequisite: Agricultural Education 276 and 277. DEYOE.

475. **Organizing and Teaching Farm Mechanics.** Farm mechanics as a phase of vocational education in agriculture; purposes, course planning for high school students, young farmers, and adult farmers, methods of teaching and evaluating, on-farm instruction, planning farm mechanics shops and facilities, providing and teaching safety in farm mechanics. S; ½ unit. Prerequisite: Agricultural Education 276 and 277. PHIPPS.

476. **Guidance in Agricultural Education.** The guidance function in high school, young farmers and adult farmers classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment in farming, placement, follow-up. S; ½ unit. Prerequisite: Agricultural Education 276 and 277. KREBS.

477. **Field Studies in Agricultural Education.** For experienced teachers of agriculture. Study of policies, programs, and practices in the schools in which the students are employed; planning and introducing new policies, programs, and practices. I (offered extramurally only); ½ unit. Prerequisite:

Agricultural Education 276 and 277. Available only to persons employed in Illinois. DEYOE, HAMLIN.

481. **History and Basic Concepts of Vocational Education.** A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. I; 1 unit. KARNES.

482. **Research Studies in Industrial Education.** Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student proposes and completes a brief research, or plans in detail a major research project to be completed later. II; 1 unit. EVANS, KARNES.

487. **Seminar in Industrial Education.** I; 1 unit. EVANS.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses. Study of basic concepts underlying course construction in industrial education. II; 1 unit. Prerequisite: Undergraduate work in industrial education. EVANS, KARNES.

489. **Administration and Supervision of Industrial Education.** Problems and approved practices in the administration and supervision of programs of industrial education in the secondary schools. I; 1 unit. Prerequisite: Undergraduate work in industrial education. KARNES.

490. **Seminar for Advanced Students of Education.** Open only to persons who have been admitted to candidacy for the degrees of Doctor of Philosophy or Doctor of Education. Sections of this seminar are usually offered in the following areas: philosophical and social foundations of education, psychological foundations of education, elementary education, secondary education, educational administration, guidance and counseling, education of the exceptional child, industrial arts and vocational education, agricultural education, and home economics education. I, II; 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the degree of Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation; tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. I, II; 1 to 2 units. STAFF.

495. **Theory of Measurement.** Same as Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. I; 1 unit. Prerequisite: Education 496 or Psychology 407; Education 392 or Psychology 290, or equivalent. CRONBACH, HASTINGS, KAISER.

496. **Statistical Methods in Education.** First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and the testing of statistical hypotheses; and other applications of statistics to educational research. I; 1 unit. Prerequisite: Education 390. GAGE, ODELL, PINGRY.

497. **Advanced Statistical Methods in Education.** An advanced course in statistical methods applied to educational research. Statistical estimation, analysis of variance and co-variance, statistical design of experiments, introduction to

factor analysis, the use of mathematical models in educational theory. II; 1 unit. Prerequisite: Education 496.

498. **Theory of Educational Evaluation.** Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. II; 1 unit. Prerequisite: Education 496. HASTINGS.

499. **Thesis Research.** Individual direction of research and thesis writing. I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **The History of Education.** Brief, introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. I, II; ½ unit. ANDERSON.

301. **Philosophy of Education.** Based on Dewey's *Democracy and Education,* this course is an examination of experimentalist philosophy in its bearings on educational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. I, II; ½ unit. MCMURRAY.

302. **History of American Education.** The development of American education in relation to political, social, and cultural developments. Special attention is given to the influence of movements in the cultural environment upon evolving conceptions of educational theory and practice. I, II; ½ unit. ANDERSON.

303. **Comparative Education.** A study of selected national systems of education in their differing cultural settings. I, II; ½ unit. BENNER, KAULFERS.

304. **Social Foundations of Education.** An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. I, II; ½ unit. SMITH, STANLEY.

311. **Psychology of Learning for Teachers.** A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understandings. I, II; ½ unit. Prerequisite: Education 211; practice teaching or teaching experience. BLAIR, CRONBACH, GRIFFITH, GRONLUND, JONES, POTTHOFF, SIMPSON.

312. **Mental Hygiene and the School.** An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. I, II; ½ unit. Prerequisite: Education 211; practice teaching or teaching experience. BLAIR, GRIFFITH, GRONLUND, JONES, POTTHOFF, SIMPSON.

315. **Sociology of Education.** Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. I, II; ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. SHIDELER.

316. **The Gifted Child in School and Society.** A consideration of the gifted in

society: who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the consideration and evaluation of instructional and administrative adjustments that should be made for the gifted in the educational structure. I; ½ unit. Prerequisite: Psychology 100. NEWLAND.

318. **Workshop and Laboratory in Education of Exceptional Children.** Observation of special laboratory classes of various types of exceptional children; group discussions; conferences with specialists as consultants; work on a project of particular concern to the individual student. S; 1 unit for four weeks; 2 units for eight weeks. GOLDSTEIN.

319. **Special Education of the Deaf.** Survey of the curriculum and techniques in pre-schools, kindergarten, and primary and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child. A study of sense training, lip reading, vocabulary development, reading techniques, language and speech development, auditory training, and curriculum construction. I; 1 to 1½ units. Prerequisite: First three years of curriculum for teachers of the deaf, or equivalent.

320. **Special Education of the Deaf.** Continuation of Education 319. II; 1 to 2 units. Prerequisite: Education 319.

321. **Care and Education of Orthopedically Handicapped Children.** Survey of orthopedic handicaps in children, psychological and social effects of such handicaps, and the kinds of schools and services provided for the education of the various types of crippled children. The education of the cerebral palsied child is emphasized. S; 1 unit. Prerequisite: A teacher's certificate or a major in some area of special education.

322. **Psychology and Education of the Mentally Handicapped.** A study of the social, emotional, physical, and learning characteristics of mentally handicapped children; methods of diagnosis and differentiation; educational organization and teaching techniques employed for their rehabilitation. I; ½ unit. Prerequisite: Education 231. GOLDSTEIN, KIRK.

323. **Psychology and Education of the Mentally Handicapped.** Continuation of Education 322, with emphasis on curriculum. II; ½ unit. Prerequisite: Education 322. GOLDSTEIN, KIRK.

324. **Mental and Educational Measurement of Exceptional Children.** Designed primarily to develop an understanding of and ability to interpret the results of psychological and educational tests. Some practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing children who are acoustically, orthopedically, visually, or mentally handicapped, or speech defective. II; ½ to 1 unit. Prerequisite: Education 117 or consent of instructor. KIRK, NEWLAND.

325. **Introduction to Guidance and Counseling.** Basic concepts and practices of guidance in schools; what the teacher can do in guidance. Students may not register for credit in both Education 325 and 425. I, II; ½ to 1 unit. Prerequisite: Eight semester hours in education and psychology. OHLSEN.

326. **Introduction to Vocational Rehabilitation Counseling.** A survey of the history and development of vocational rehabilitation programs; contributions of related disciplines and their integration; basic procedures and problems of vocational rehabilitation counseling. I; ½ unit. Prerequisite: Consent of instructor. PATTERSON.

335. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program,

experiences, and techniques of value in teaching and of the role of the classroom teacher, and the specialist. Opportunity for experience in field and laboratory work. I, II; ½ unit. Prerequisite: Education 101 and 201 or equivalent; two years of college science. ATKIN, BURNETT.

336. **Primary Reading.** Critical evaluation of current schools of thought with regard to the teaching of reading and an analysis of the concept of learning as well as the meaning of reading upon which each school is based. Attention is given to reading as a part of the total growth process of the child and to knowledge of methods and materials used in teaching beginning reading. I, II; ½ unit. Prerequisite: Education 101, 201, and 230. MOORE, STENDLER.

337. **Art Education in the Elementary School.** Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. I, II; ½ unit. Prerequisite: Education 101, 201, and 230. SCHULTZ.

338. **Supervision of Art in the Public Schools.** A study of supervisory and administrative problems encountered in elementary and secondary school art programs. II; ½ unit. Prerequisite: Education 337 or consent of instructor.

354. **Audio-Visual Materials and Problems.** Audio-visual materials are examined from the point of view of their effectiveness and possible utilization in the school program. Recent investigations on materials and methods of presentation are studied to ascertain their pedagogical implications. The technical and administrative problems of integrating audio-visuals into the school curriculum are considered. S; ½ unit. Prerequisite: Education 211, 231, or 241. PETERSON.

370. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meeting in August. Other meetings in centers in the state convenient to first-year teachers. Visits by instructor to schools in which the students are employed. I, II; ½ unit. Prerequisite: Agricultural Education 276 and 277. KREBS, PHIPPS.

381. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. I; ½ to 1 unit. EVANS, KARNES.

382. **Organization and Administration of Diversified Occupations Programs.** Designed to provide the specific professional training required of teachers and coordinators who are to conduct programs of diversified occupations in the secondary schools. II; ½ to 1 unit. KARNES.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. II; ½ to 1 unit. EVANS, KARNES.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. S; 1 unit. Prerequisite: Sixteen hours in industrial education. LUX, TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, together with their relationships to other educational agencies. II; 1 unit. EVANS.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. I, II; 1 unit. Prerequisite: Ten hours of undergraduate credit in industrial education. EVANS, KARNES.

390. **Elements of Educational Statistics.** Designed for terminal value for pro-

fessional training of students not intending to pursue advanced graduate work, and for introductory value for students continuing graduate study in education. Includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. I, II; 1 unit. ODELL.

391. **Construction and Use of Tests in Teaching.** Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking procedure. Designed primarily for classroom teachers. I; ½ to 1 unit. Prerequisite: Education 211. ODELL.

392. **Introduction to the Principles of Measurement.** Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. II; ½ to 1 unit. Prerequisite: Education 211. CRONBACH, GAGE, ODELL.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the degree of Master of Science in Electrical Engineering and Doctor of Philosophy in Engineering is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois in the option in which advanced work is desired. The fields of specialization are physical electronics and electronic engineering, communication engineering, and power engineering. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. An applicant's undergraduate grade-point average must be at least 3.75.

Courses for advanced undergraduates and graduates are also open for credit to students with majors in other departments who have the proper prerequisites.

The objectives of a well-rounded graduate program in electrical engineering may be classified as follows:

(1) Development of a more thorough understanding of the basic fundamentals of electrical engineering.

(2) Development of better tools for the solution of electrical engineering problems.

(3) Uncovering of special characteristics of initiative and resourcefulness.

(4) Development of a specialist's understanding in some area of the electrical engineering field.

An advisory committee of graduate faculty members is appointed for each graduate student who completes the first year of graduate work. This committee and the student work out the graduate study program to be followed. A qualifying examination is ordinarily held in the fall and spring of each year for graduate students who have received the Master of Science degree. The results of this examination are available to the advisory committee as an aid in counseling.

Students in all areas of electrical engineering are required to complete satisfactorily at least one graduate (400) course in the general area of circuits and at least one graduate (400) course in field theory for the Master of Science degree. Students who already have the master's degree must furnish evidence of equivalent training or enroll in such courses in the first year of residence. It is

also expected that the student enroll in such additional mathematics work as a review of his training and the field in which he specialized would indicate advisable. Advanced courses in mathematics, physics, chemistry, mechanics, and in other branches of engineering are suggested as suitable minor subjects. A minor sequence in physics to include Physics 381 and 362 is recommended. It is strongly recommended that students who are candidates for the Master of Science degree and expect to continue graduate work elect to write a thesis.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in electrical engineering may be obtained from the head of the department, 155 Electrical Engineering Building.

In addition to University fellowships, industrial fellowships are awarded to qualified graduate students in electrical engineering upon recommendation of the department. Some are restricted to students interested in a specific area or field. Application is made in the same way as for University fellowships. At the present time the following industrial fellowships are available: Galvin Fellowship, sponsored by Motorola, Inc. of Chicago, General Electric Company Fellowship, Radio Corporation of America Fellowship, Sperry Gyroscope Company Fellowship, Texas Instrument Fellowship in Solid State Physics, Westinghouse Educational Foundation Fellowship. These fellowships ordinarily carry a stipend of at least $1,500 for the academic year and tuition fees are waived.

Instructor fellowships are available which permit outstanding instructors to take up to half-time graduate work while teaching half time, the fellowship stipend supplementing the reduced teaching salary. Thus the student is able to make more rapid progress toward the graduate degree.

GRADUATE TEACHING FACULTY

Professors: E. C. Jordan (Head of Department), G. E. Anner, L. B. Archer, J. Bardeen, W. H. Bruckner, P. D. Coleman, G. A. Deschamps, W. L. Emery, W. L. Everitt, M. A. Faucett, G. H. Fett, W. J. Fry, L. Goldstein, H. N. Hayward, M. S. Helm, C. A. Keener, R. E. Meagher, W. E. Miller, C. E. Skroder, M. E. Van Valkenburg, H. M. Von Foerster, N. Wax, J. E. Williams.

Associate Professors: W. G. Albright, D. S. Babb, A. D. Bailey, P. R. Egbert, H. W. Horn, H. Mahrous, M. S. McVay, D. E. Muller, T. A. Murrell, J. P. Neal, G. R. Peirce, J. E. Robertson, J. P. Ruina, P. F. Schwarzlose, G. W. Swenson, Jr., H. D. Webb.

Assistant Professors: R. E. Bedford, M. H. Crothers, A. A. Dougal, C. D. Hendricks, E. H. Holt, Y. T. Lo, P. E. Mayes, R. Mittra.

COURSES FOR GRADUATES

0. **Seminar.** Required of all graduate students. I, II; no credit. Jordan.

0. **Engineering Analysis.** Static and dynamic field problems with emphasis on the relationships between the various branches of engineering and the development of the use of mathematics as a tool in the solution of complex problems. I, II; 1 unit. Bailey.

2. **Advanced Engineering Measurements.** Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. I, II; 1 unit. Hayward, Peirce.

. **Servomechanisms and Automatic Control Devices.** Fundamental theory of

servomechanisms and other automatic control devices, electrical analogies, stability, transfer functions, and on-off mechanisms. I, II; 1 unit. FETT.

414. **Foundations of Electrical Network Theory, I.** Formulation and study of foundation axioms of electrical networks, topological basis of mesh and node methods, mesh and node equations by means of matrix transformations, and general proofs of standard network theorems. I, II; 1 unit.

416. **Advanced Circuit Analysis.** Fundamentals of network theory and theorems, transients, Laplace transform, and the complex frequency concept. I, II; 1 unit. MCVAY, VAN VALKENBURG.

418. **Electric and Magnetic Fields.** Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. I, II; 1 unit. EMERY.

419. **Dynamic Network Analysis.** Extension of static network theory to networks having relative motion between elements, with particular emphasis on the analysis of rotating electrical apparatus when considered as an integral part of complex control systems. I, II; 1 unit. Prerequisite: Electrical Engineering 416.

420. **Electromagnetic Waves and Radiating Systems.** Fundamental electromagnetic theory with applications to transmission lines, wave guides, and antennas. I, II; 1 unit. JORDAN, MAYES.

421. **Advanced Electromagnetic Engineering.** Huyghen's principle; uniquenes and reciprocity theorems; Babinet's principle; reaction concept; variationa methods; applications to plane, cylindrical, and spherical wave problems Application to a general method of calculating the result of any practica measurement such as antenna radiation pattern and impedance, the para meters of wave guides and cavities, and observations on scattering and dif fraction. I, II; 1 unit. Prerequisite: Electrical Engineering 420. MAYES.

422. **Advanced Communication Networks.** Fourier integral and matrix algebra analysis of networks, and network synthesis for wide band operation. I, II 1 unit. SKRODER.

423. **Electron and Ion Dynamics.** Laplace equation, conformal transformation Poisson's equation with initial velocities and transit time, electron optics, an electron ballistics of klystrons and magnetrons. I, II; 1 unit. Prerequisit Credit or registration in Electrical Engineering 420. DOUGAL, WAX.

424. **Theory of Gaseous Discharge Devices.** Motion of ions and electrons; ioniz tion and deionization; space charge and plasma; glow and arc discharge circuit interruption; arc extinction problems. I, II; 1 unit. GOLDSTEIN.

426. **Electroacoustical Systems.** A study of the solutions of differential equatio of wave motion with applications to vibrating strings, membranes, roo sonic systems, loud speakers, microphones, galvanometers. I, II; 1 un FRY, SWENSON.

427. **Boundary Value Problems.** Derivation and solution of partial different equations and integral equations of mechanics and electricity and magnetis study of the analysis of wave motions. I, II; 1 unit. COLEMAN.

428. **Nonlinear Oscillating Systems.** Criteria for stability of nonlinear oscillatio nonlinear resonance; study of analytical methods; harmonics and subh monics, and relaxation oscillations. I, II; 1 unit. CROTHERS, FETT.

429. **Vacuum Tube Circuit Analysis.** Vacuum tube network theory, feedba circuits and amplifiers, stability, equalizers, and relations between co ponents of network functions. I, II; 1 unit. FETT.

430. **Gas Tube Circuit Analysis.** Equivalent circuit of gas tubes at low and h frequencies, circuit analysis, and rectifiers. II; 1 unit.

431. **Microwave Circuits.** Four-terminal networks and transmission line theory, bilinear transformations, wave guides, the generalized impedance concept, expansion of fields in normal modes, resonant cavities, and measurement techniques. I, II; 1 unit. Prerequisite: Electrical Engineering 420.

433. **Transmission of Information.** II; 1 unit. RUINA, WAX.

435. **Conduction of Electricity in Solids.** Same as Physics 435. Application of quantum principles to conduction of electricity in solids, impurity and intrinsic semiconductors, Hall and thermoelectric effects, photoconductivity, p-n junctions, and rectifying contacts, theory and characteristics of transistors. II; 1 unit. Prerequisite: Physics 381 or consent of instructor. BARDEEN.

436. **Applied Electrodynamics.** Tensor form of Maxwell's equations, special relativity, radiation reaction, integration of wave equations. Fourier analysis of radiation fields, Lagrange and Hamiltonian equations. Applications to submillimeter wave generation, Cerenkov effect, radiation from particle accelerators, electron bunching at high energies. II; 1 unit. Prerequisite: Electrical Engineering 420 and 423. COLEMAN.

40. **Advanced Power Circuit Analysis, I.** Special methods of polyphase circuit analysis, transients in multiple loop lumped constant circuits by differential equations and by Heaviside expansion theorem, and study of circuits having nonlinear parameters by step-by-step method. I, II; 1 unit. HELM.

41. **Advanced Power Circuit Analysis, II.** Transients in multiple loop lumped constant circuits by Fourier integral and by Laplace transforms, and study of steady state relations and transients in distributed constant circuits. I, II; 1 unit. Prerequisite: Electrical Engineering 440. HELM.

42. **Advanced Analysis of Alternating Current Machinery.** Steady state analysis of synchronous machines, round rotor and salient poles, magneto-motive forces with symmetrical and unsymmetrical windings, torque angle characteristics, vibration, and noise. I, II; 1 unit. KEENER.

43. **Analysis of Dynamo Machines Under Transient Conditions.** Analysis of the operation of alternating and direct current machines under transient conditions, armature and field phenomena and mutual reactions of dynamo machines with system transients. I, II; 1 unit. Prerequisite: Electrical Engineering 442. KEENER.

4. **Advanced Power System Analysis.** Electrical and mechanical properties of transmission systems, calculations of fault currents, power diagrams, and power limits. I, II; 1 unit. Prerequisite: Electrical Engineering 440. FAUCETT.

5. **Power System Transients and Stability.** Steady state power limits, criteria for loss of synchronism, effects of voltage regulation, exciters, and steady state as influenced by dynamic stability. I, II; 1 unit. Prerequisite: Electrical Engineering 444. FAUCETT.

6. **Electrical Design (Apparatus).** Properties of materials, field mapping, leakage fields, cooling and rating of apparatus, limitations affecting design, prediction of operating characteristics, and special design problems. I, II; 1 unit. ARCHER.

7. **Electrical Design (Power System).** Sources of energy, location of generating stations, selection of units, location of transmission lines, layouts of systems, and extension of established systems. I, II; 1 unit. FAUCETT.

. **Network Synthesis.** A study of methods for the synthesis of networks for prescribed driving-point or transfer characteristics. I; 1 unit. Prerequisite: Mathematics 345. VAN VALKENBURG.

. **Network Synthesis.** A continuation of Electrical Engineering 451. II; 1 unit. Prerequisite: Mathematics 345. VAN VALKENBURG.

453. **Automatic Feedback Control System Synthesis.** Synthesis of automatic feedback control systems through pole-zero configurations. II; 1 unit. Prerequisite: Electrical Engineering 413 and 451. VAN VALKENBURG.

461. **Methods of Illumination Calculations.** Fundamentals of the light field, illumination in space, the light vector, plots of fields, and applications of light fields to engineering problems. I, II; 1 or 2 units. HORN.

462. **Colorimetry in Illumination.** Color, vision, color of sources, surfaces and filters, direct measurements, measurements of spectral distributions, methods of computing tristimulus values and chromaticity coefficients, color temperature, color systems and their interrelation, linear and homogeneous transformation, color discrimination, and harmony and applications. I, II; 1 unit. HORN.

464. **Advanced Illumination Design.** Design of lighting equipment for both utility and comfort, control of glare through proper brightness contrasts, design for special applications, and design of floodlighting and streetlighting equipment. I, II; 1 or 2 units. HORN.

493. **Research.** I, II; ½ to 4 units. STAFF.

497. **Electrical Engineering Problems.** Special electrical engineering problems. I; ½ to 2 units. STAFF.

498. **Electrical Engineering Problems.** Special electrical engineering problems. II; ½ to 2 units. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

320. **Circuit Analysis.** Detailed and analytical solution of periodic current cir cuits; networks and network theorems; coupled circuits. I, II; 0 to 1 unit Prerequisite: Electrical Engineering 126; Physics 108; credit or registratio in Electrical Engineering 321 and in Mathematics 341, 342, 343, or 345.

321. **Circuit Laboratory.** To accompany Electrical Engineering 320. I, II; 0 t ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 320

322. **Circuit Analysis.** Continuation of Electrical Engineering 320. Wave analysis three-phase circuits; three-phase power and energy measurements; symmet rical components analysis; filters; transients. I, II; 0 to 1 unit. Prerequisite Electrical Engineering 320 and 321; credit or registration in Electrical Engi neering 323.

323. **Circuit Laboratory.** To accompany Electrical Engineering 322. I, II; 0 t ¼ unit. Prerequisite: Electrical Engineering 320 and 321; credit or regi tration in Electrical Engineering 322.

330. **Theory of Electrical Machinery, I.** Analysis of the electric and magnet circuits and fields of electrical machinery. I, II; 0 to ¾ unit. Prerequisit Electrical Engineering 126 or equivalent; credit or registration in Electric Engineering 320, 321, and 331.

331. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 33 I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Eng neering 330.

332. **Theory of Electrical Machinery, II.** Analysis of transformer reactors ar induction motors, and their single and polyphase characteristics. I, II; 0 ¾ unit. Prerequisite: Electrical Engineering 126 or equivalent; Electric Engineering 320, 321, 330, and 331; credit or registration in Electric Engineering 322, 323, 332.

333. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 33 I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Eng neering 332.

334. **Electrical Power Apparatus.** Single- and three-phase transformers. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 322 and 323; credit or registration in Electrical Engineering 335.

335. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 334. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 334.

336. **Electrical Power Apparatus.** Synchronous and induction generators and motors. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 334 and 335; credit or registration in Electrical Engineering 337.

337. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 336. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 336.

338. **Electrical Power Apparatus.** Direct-current generators and motors, converters, single-phase motors, frequency changers, duty cycles. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 336 and 337; credit or registration in Electrical Engineering 339.

339. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 338. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 338.

341. **Electronics.** High-vacuum and gas-filled electron tubes, circuits and applications. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321.

347. **Industrial Electronics.** Feedback systems, rectifiers, amplifiers, controls, elements of design. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 341; credit or registration in Electrical Engineering 330 or 334.

349. **Electron Tube Circuits.** Linear and nonlinear amplifiers, fundamentals of modulation and detection, oscillators, rectifiers. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322, 323, and 341; credit or registration in Electrical Engineering 353.

351. **Networks and Lines.** Reactance networks, general transmission line equations, low-loss lines, reflections. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 322.

353. **Radio Circuits.** Impedance transformation, reactance network synthesis as applied to radio frequencies; modulation theory; principles of receivers and transmitters. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322, 341, and 351; credit or registration in Electrical Engineering 349.

355. **Fields and Waves.** Theory of UHF and microwave generators; electromagnetic fields, radiation and propagation of electromagnetic energy, radiating systems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 349 and 351.

357. **Radio Astronomy.** Same as Astronomy 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. I or II; 1 unit. Prerequisite: Physics 107 and 108. Swenson, Wyatt.

361. **Elements of Illuminating Engineering Design.** Application of the fundamentals of optics and light to developments in the design of illumination equipment and lighting installations. I, II; 0 to ½ unit. Prerequisite: Mathematics 132 and 142; Physics 108.

362. **Principles of Illuminating Engineering.** Concept and units in light calculations; calculation of illumination from point, line, and surface sources; interpretation of photometric and test data. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 260; credit or registration in Electrical Engineering 363; Mathematics 345; Physics 270 or Electrical Engineering 360.

363. **Illumination and Photometry Laboratory.** Photometry and illumination measurements. I; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 362.

364. **Illumination Design and Economics.** Design of lighting systems for natural and artificial illumination; applications for interiors and exteriors in both commercial and industrial installations; economic studies; design of reflectors and lighting equipment. II; 0 to ¾ unit. Prerequisite: Electrical Engineering 362 and 363; credit or registration in Electrical Engineering 365.

365. **Illumination Design Laboratory.** To accompany Electrical Engineering 364. Checking and constructing equipment and installation designs in lighting. II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 364.

366. **Illumination Sources.** Study of natural and artificial light sources covering combustion, incandescent, and gaseous lamps, with emphasis on fundamental laws; radiation measurements and colorimetry. II; 0 to ½ unit. Prerequisite: Credit or registration in Electrical Engineering 364 and 365.

376. **Power Circuit Analysis.** Advanced analysis of circuits used for power transmission and distribution. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321.

377. **Machine Application and Control.** Analysis of electrical machinery applications; controls. II; 0 to 1 unit. Prerequisite: Electrical Engineering 336 and 337; credit or registration in Electrical Engineering 338.

378. **Fundamentals of Power Transmission Engineering.** Fundamentals of electrical and mechanical design of power transmission systems. I, II; 0 to 1 unit.

379. **Power Transmission.** Advanced analysis of electrical power transmission systems, faults, stability; network analyzer studies. II; 0 to ¾ unit. Prerequisite: Electrical Engineering 336, 337, and 378.

381. **Pulse Techniques.** Response of electrical systems to repeated transients. I, II; 0 to 1 unit.

382. **Transistor Circuits.** Introduction to circuit properties of point-contact and junction transistors and diodes; linear and nonlinear transistor circuits. With laboratory. Credit is not given for both Electrical Engineering 382 and 383. II; 1 unit. Prerequisite: Electrical Engineering 349 or equivalent course in electron tube circuits.

383. **Transistor Circuits.** Introduction to circuit properties of point-contact and junction transistors and diodes; linear and nonlinear transistor circuits. No laboratory. Credit is not given for both Electrical Engineering 382 and 383. II; ¾ unit. Prerequisite: Electrical Engineering 349 or equivalent course in electron tube circuits.

384. **Logical Design of Automatic Digital Computer Circuits.** Same as Mathematics 384. A course in the design of automatic digital computers. Major emphasis on logical structure of components and the interrelations necessary for automatic operation. I, II; 1 unit. Prerequisite: Senior standing; consent of instructor.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. II; 0 to 1 unit.

387. **Electrical Design.** Fundamental principles of electrical power apparatus design with particular application to transformers and generators. Properties of materials in common use; construction of coils; magnetic attraction; stored energy, field mapping; heat dissipation; temperature rise and rating of apparatus. For students selecting the option in power. I, II; 0 to 1 unit. Pr

requisite: Electrical Engineering 332 and 333; registration in Electrical Engineering 334 and 335.

388. **Electronic Analog Computers.** Design of analog computer elements, problem preparation, and representative solutions of physical problems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 341 and Mathematics 345, or consent of instructor.

389. **Communication Design.** Design, construction, and complete test of a radio transmitter or receiver. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 349 and 353.

391. **Boolean Algebras with Applications to Computer Circuits, I.** Same as Mathematics 391. An introduction to Boolean algebra with a discussion of the elementary applications to set theory, logic, and both relay and electronic switching circuits. The Harvard chart method and other methods for circuit simplification are treated both as applied to single output and multiple output circuits. I, II; ½ to 1 unit. Prerequisite: Senior standing; consent of instructor.

392. **Boolean Algebras with Applications to Computer Circuits, II.** Same as Mathematics 392. The notion of time as a parameter is introduced into the theoretical treatment of switching circuits. Examples of synthesis of time-dependent circuits are given using mathematical techniques. I, II; ½ to 1 unit. Prerequisite: Mathematics 391.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric)

Students who enter graduate work with English as their major subject must have attained a grade-point average of 3.6 or higher. All students must present the equivalent of at least fourteen hours of undergraduate work in English or American literature, not including required college work in rhetoric. They must also present the equivalent of four semesters of college work in Latin, Greek, French, or German, or, lacking such credit, make good the deficiency before receiving the master's degree. (Four semesters of college Spanish are accepted only from candidates for the Master of Arts in the Teaching of English, not from candidates for the Master of Arts in English.) It is suggested that undergraduate work in English is best distributed in the following way to provide a foundation for graduate study: (1) historical surveys of English and American literature; (2) a course or courses on major writers, e.g., Chaucer, Shakespeare, Milton, Whitman, Melville, etc.; (3) period courses in the Renaissance, seventeenth, eighteenth, nineteenth, or twentieth centuries; (4) courses in literary types, e.g., the novel, poetry, drama. Students are also urged to offer courses in history and philosophy that are pertinent to an understanding of literature.

Students who have as undergraduates made English their minor may be admitted to such courses as in the judgment of the instructors in charge they are qualified to pursue.

Degree of Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates for the degree of Master of Arts in English are required to choose at least four of their courses from those at the 300 level. They must also give evidence that they have taken the equivalent of at least two years of undergraduate work in French, German, Latin, or Greek. They may do this (1) by presenting evidence that they have satisfactorily completed two years of undergraduate study in either language, (2) by passing the reading examination for the doctorate in either language, or (3) by taking and passing with a grade of C either French 400 and 401 or German 400 and 401.

Candidates must also pass a qualifying examination. This is a three-hour written examination devised to test the student's knowledge of and interpretive skill in such English and American literature as an undergraduate English major may reasonably be expected to have acquired. The examination is given during the first week of each semester and of the summer session. It must be taken during the student's first semester of residence.

A master's thesis is not required, although a student may elect to offer one with the approval of his adviser.

Degree of Master of Arts in the Teaching of English. Candidates for the degree of Master of Arts in the Teaching of English must earn four units in English, at least two of them in courses at the 400 level, and they must pass the same qualifying examination as is required for the degree of Master of Arts in English. Those who fail the qualifying examination may substitute two additional units of work beyond the eight normally required. They must also give evidence that they have taken the equivalent of at least two years of undergraduate work in French, German, Latin, Greek, or Spanish.

Specific requirements are English, four units (students who intend to teach in junior college should take Rhetoric 480); education, two units, including two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in English and the electives must be selected with the approval of the head of the department. The electives may be in English, in education, or, in exceptional cases, in other subjects. Candidates for this degree should consult Professor J. N. Hook, 121 Lincoln Hall.

Degree of Doctor of Philosophy.

English 400. All entering graduate students who intend to proceed beyond the master's degree are required to take English 400, Introduction to Advanced Graduate Study, during one of their first two semesters in residence, summer session not included.

Foreign Languages. Each student is required to demonstrate proficiency in French and German by a written examination.

Minor Subjects. Students may offer either a double minor, which includes philology and one other subject, or a sole minor in philology.

If the student elects the former option, he takes English 401, Old English: Anglo-Saxon; 402, Old English: Beowulf; and 403, History of the English Language, in satisfaction of the requirements for the first minor. The second minor consists of at least two units in philosophy, history, or a foreign literature (French, German, Greek, Italian, Latin, Spanish). Under exceptional circumstances the student may be permitted by the head of the department to offer a subject other than one of these for his second minor.

If the student elects the latter option he takes English 401, 402, and 403; one unit chosen from German 426, French 475 and 476; and one additional unit chosen from these courses or English 405 or 408.

Philology Examination. Each student must pass a comprehensive examination in English philology at least one term before he takes his preliminary examination. This examination is given in October and May each year. He is excused from this examination if he earns an A in each of the three basic philology courses.

Preliminary Examination. The preliminary examination is given in October and May of each year. It consists of two parts:

(1) The written examination. Each student takes written examinations in four of the following periods: English literature before 1500, English literature in the sixteenth century, English literature in the seventeenth century, English literature in the eighteenth century, English literature in the nineteenth century, American literature before 1865, American literature after 1865. These examinations last from three to four hours each and are given on successive days.

(2) The oral examination. The oral examination covers (a) the four areas

chosen for the written examinations; (b) the sole or second minor; (c) in a less intensive form the remaining areas of English and American literature; (d) the field of the candidate's specialization; and (e) a major work in this field, selected by the head of the department long enough before the examination to allow time for preparation.

Thesis. The student writes a dissertation under the direction of a graduate professor who also serves as his adviser.

Further details may be secured from the Department of English.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in English may be obtained from the head of the department, 109 English Building.

GRADUATE TEACHING FACULTY

Professors: R. W. Rogers (Head of Department), E. H. Davidson, G. B. Evans, J. T. Flanagan, H. F. Fletcher, R. A. Gettmann, M. T. Herrick, A. G. Holaday, J. N. Hook, P. N. Landis, B. A. Milligan, S. Paul, R. Pratt, C. W. Roberts, C. H. Shattuck, R. M. Smith.

Associate Professors: A. D. Culler, M. S. Goldman.

Assistant Professors: A. L. Altenbernd, R. L. Haig, B. Harkness, G. P. Haskell, Cornelia Kelley, E. Nehls, H. F. Robins, R. Schneider, A. L. Scott, G. Scouffas, G. B. Stillwell.

Instructor: L. A. Muinzer.

English Literature

COURSES FOR GRADUATES

400. **Introduction to Advanced Graduate Study.** A consideration of the methods of literary scholarship, the objectives of literary criticism, and the profession of college English teaching. Required of all candidates for the degree of Doctor of Philosophy in English. I; ½ unit. Davidson, Gettmann, Rogers.

401. **Old English: Anglo-Saxon.** An introduction to the language before 1000 A.D. I; 1 unit. Muinzer.

402. **Old English: Beowulf.** II; 1 unit. Prerequisite: English 401. Smith.

403. **History of the English Language.** A study of the development of the language from the earliest stages to the present time. I; 1 unit. Smith.

405. **Middle English.** Introduction to middle English dialects, with special emphasis on the East Midland. II; 1 unit. Offered in 1958-1959 and in alternate years. Smith.

407. **Studies in Chaucer and His Times.** A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. I; 1 unit. Pratt, Smith.

408. **Studies in Chaucer and His Times.** Continuation of English 407. II; 1 unit. Pratt, Smith.

411. **Studies in Sixteenth Century Literature.** I; 1 unit. Milligan.

412. **Studies in Sixteenth Century Literature.** Continuation of English 411. II; 1 unit. Milligan.

417. **Studies in Seventeenth Century Literature.** I; 1 unit. Fletcher.

418. **Studies in Seventeenth Century Literature.** Continuation of English 417. II; 1 unit. Fletcher.

421. **Studies in Eighteenth Century Literature.** I; 1 unit. Rogers.

422. **Studies in Eighteenth Century Literature.** Continuation of English 421. II; 1 unit. Rogers.

427. **Studies in the Romantic Movement.** I; 1 unit. GETTMANN.

428. **Studies in the Romantic Movement.** Continuation of English 427. II; 1 unit. GETTMANN.

431. **Studies in Victorian Literature.** I; 1 unit. CULLER.

432. **Studies in Victorian Literature.** II; 1 unit. Prerequisite: English 431. CULLER.

441. **Studies in Literary Theory.** The analysis, in accordance with aesthetic principles, of major documents in the history of poetics in order to formulate the central problems of literary theory and to examine proposed solutions to them. I; 1 unit.

447. **Background Materials for High School Teachers of English.** Investigation of the content that is desirable in high school literature and composition. S; 1 unit. HOOK.

450. **Problems in Bibliographical Method.** Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. I or II; 1 unit. Prerequisite: Consent of instructor. EVANS.

457. **Problems in Medieval Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. Medieval poetry, with attention to models, materials, and principles. I; 1 unit. PRATT.

461. **Problems in Spenser.** A study of special problems relating to the works of Edmund Spenser, his background in England and in Ireland, and the second half of the sixteenth century. I or II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: English 326 or any course in the sixteenth century. SMITH.

462. **Problems in Tudor Drama.** I; 1 unit. HOLADAY.

463. **Problems in Shakespeare.** I; 1 unit. EVANS.

464. **Problems in Elizabethan Drama.** II; 1 unit. EVANS.

467. **Problems in Milton and His Age.** I; 1 unit. Prerequisite: English 417 and 418; second-year graduate standing. FLETCHER.

468. **Problems in Milton and His Age.** Continuation of English 467. II; 1 unit. Prerequisite: English 417 and 418; second-year graduate standing. FLETCHER.

472. **Problems in the Eighteenth Century Novel.** I or II; 1 unit. ROGERS.

477. **Problems in Prose Fiction.** I; 1 unit. Prerequisite: Second-year graduate standing. GETTMANN.

478. **Problems in Prose Fiction.** Continuation of English 477. II; 1 unit. Prerequisite: Second-year graduate standing. GETTMANN.

484. **Problems in Twentieth Century English Literature.** I, II; 1 unit. Prerequisite: A survey of English literature or consent of instructor. HARKNESS, NEHLS.

499. **Thesis Research.** I, II; 0 to 4 units. CULLER, EVANS, FLETCHER, GETTMANN, GOLDMAN, HAIG, HARKNESS, HERRICK, HOLADAY, HOOK, LANDIS, MILLIGAN, NEHLS, PRATT, ROBERTS, ROBINS, ROGERS, SHATTUCK, SMITH, STILLWELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Professional Expression.** Problems of professional expression considered in the light of extensive reading and discussion of examples from biography, poetry, and drama, exposition and persuasion. Special application is made to approve projects of some complexity, from which publication or equivalent use is effected. I, II; 1 unit. Prerequisite: Advanced or graduate standing; consent of instructor.

311. **Chaucer.** I; ¾ unit. STILLWELL.

313. **Medieval Literature.** Medieval literature, for the most part in translation, with emphasis on the Latin and continental vernacular traditions, including such forms as history, romance, drama, saints' legends, hymns, and lyrics. I; ¾ unit. PRATT, STILLWELL.

314. **Medieval Literature.** Medieval literature, for the most part in translation, with emphasis upon the Middle English period. II; ¾ unit. PRATT, STILLWELL.

320. **Arthurian Romances.** The origin and growth of the early legends and their later development in English from Malory to Tennyson and Robinson. I or II; ¾ unit. SMITH.

325. **English Literature from 1588 to 1660.** A survey of English literature during the Renaissance. Sidney, Marlowe, Donne, Jonson, Herrick, Bacon, Burton, and other writers. II; ¾ unit. MILLIGAN.

326. **Spenser.** I or II; ¾ unit. GOLDMAN.

336. **English Drama Exclusive of Shakespeare.** From 1600 to 1700. I, II; ¾ unit. HERRICK.

337. **Studies in Shakespeare.** Nine plays. Special attention given to the modern critical approach and to the principal Shakespearean critics. S; ¾ unit. Prerequisite: English 131 or equivalent; consent of instructor. EVANS.

338. **Tragedy.** Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. I, II; ¾ unit.

339. **Comedy.** The history and theory of comic drama. I or II; ¾ unit. SHATTUCK.

342. **The Poetry of Milton.** Origins, forms, artistic and ethical values; Milton's place in English literary history. II; ¾ unit. FLETCHER.

345. **The Metaphysical Poets.** Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughan, Crashaw), with special emphasis on the poetry of John Donne. I or II; ¾ unit. EVANS, MILLIGAN.

346. **The Age of Dryden.** A study of Restoration literature, dramatic and nondramatic, centered around Dryden. I; ¾ unit. EVANS.

348. **Swift, Pope, and Fielding.** A study of the principal ideas and methods of satire as revealed in the writing of the three major English satirists. I, II; ¾ unit. Prerequisite: A course in English literature. HAIG.

349. **Dr. Johnson and His Circle.** The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan. Lectures establish the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. I, II; ¾ unit. HAIG.

351. **The Mid-Victorian Novel.** Thackeray, Charlotte Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. II; ¾ unit. HARKNESS, SCHNEIDER.

361. **The Tragic in Modern Fiction.** Thematic approach to the British and American novel in the context of modern European fiction and western literary tradition. Conrad, Lawrence, Joyce, and Faulkner, supplemented by European novelists. I; ¾ unit.

363. **Introduction to Comparative Literature.** Same as German 363. A comparative study of great books in Greek, Roman, Italian, and Spanish literature. I; ½ unit. ALLEN, LANDIS.

364. **Introduction to Comparative Literature.** Same as German 364. A comparative study of great books in French, German, and English literature. II; ½ unit. JACOB, LANDIS.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as Speech 371. I; ½ to 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism. Sidney to the Present.** Same as Speech 372. II; ½ to 1 unit. HERRICK.

382. **The Plays of Bernard Shaw.** I; ¾ unit. SHATTUCK.

383. **English Literature in the Twentieth Century.** An introductory survey emphasizing Shaw, the Edwardian novelists, Yeats, Joyce, Lawrence, Eliot, the Bloomsbury group, the satirists of the twenties, and such recent writers as Auden, Orwell, and Graham Greene. I; ¾ unit. HARKNESS, NEHLS.

American Literature

COURSES FOR GRADUATES

437. **Studies in American Literature: 1600 to 1800.** Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Enlightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: A survey course in American literature or consent of instructor. DAVIDSON.

487. **Problems in American Literature and Cultural History.** A conference and research course devoted to intensive studies in the relation of selected writers and problems in American literature to critical movements. I, II; 1 unit. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN, PAUL.

488. **Problems in American Literature and Cultural History.** Continuation of English 439. I, II; 1 unit. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN, PAUL.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. I, II; 0 to 4 units. DAVIDSON, FLANAGAN, HASKELL, KELLEY, PAUL, SCOTT.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **The American Drama.** An historical survey of the American drama from the beginning to Clyde Fitch, including the reading of a large number of representative plays. I; ¾ unit. Offered in 1958-1959 and in alternate years. FLANAGAN.

316. **The American Drama.** An historical survey of the American drama from Clyde Fitch to the present, including the reading of a large number of representative plays. II; ¾ unit. Offered in 1958-1959 and in alternate years. FLANAGAN.

318. **The American Novel: Cooper to Norris.** I, II; ¾ unit. DAVIDSON, HASKELL.

352. **American Literature: Irving to Whitman.** A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. II; ¾ unit. DAVIDSON, PAUL.

353. **Studies in Middle Western Literature.** A survey of Middle Western literature from about 1825 to Dreiser, with special emphasis on the development of realism in poetry and fiction. I; ¾ unit. Offered in 1959-1960 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

354. **Studies in Middle Western Literature.** A survey of Middle Western literature from Dreiser to the present, with special emphasis on the development of realism in poetry and fiction. II; ¾ unit. Offered in 1959-1960 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

357. **Folklore in American Literature.** A study of American folklore, including

folktales, themes, and characters, with special references to the appearance of such material in American fiction, poetry, and drama. I; ¾ unit. FLANAGAN.

375. **Henry James and the Technique of Fiction.** A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. I; ¾ unit. Prerequisite: Consent of instructor. KELLEY.

376. **American Criticism and American Culture.** This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. II; ¾ unit. Prerequisite: English 113 and 114 or English 255 and 256. PAUL.

380. **Mark Twain and the Rise of Realism.** A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900. II; ¾ unit. SCOTT.

381. **The Twentieth Century American Novel.** Dreiser, Fitzgerald, James, Hemingway, Lewis, Anderson, Dos Passos, Wolfe, Faulkner, and Steinbeck. I; ¾ unit. SCOUFFAS.

Rhetoric and Composition

COURSES FOR GRADUATES

480. **The Theory and Practice of English Composition.** An examination of modern prose style and a consideration of problems confronting writers and teachers of writing at the college level. I, II; ½ unit. ROBERTS.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

388. **English as a Second Language: A Course for Teachers.** Methods and materials for teaching English as a second language. I, II; ¾ unit.

ENTOMOLOGY

The Department of Entomology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. A prerequisite for graduate work in entomology is a grade-point average of at least 3.5.

Previous training in entomology is not essential. It is recommended that students who intend to study for advanced degrees in entomology or to pursue an entomological career gain a thorough grounding in the fundamentals of physical and biological science, in mathematics and the other liberal arts, and in the techniques of communication. Otherwise it is necessary to take time from graduate studies to repair deficiencies in these areas.

Candidates for the degree of Master of Science in Entomology are required to earn two units of credit in a basic sequence that includes the fundamentals of insect morphology, insect physiology, and insect taxonomy, plus one unit each in more advanced courses in insect morphology, insect physiology, and insect control. Electives make up the balance of the eight-unit requirement. A reading examination in one foreign language must be passed during the first semester. Not more than two units of research credit may be elected, and if research credit is presented a thesis is required. The candidate must pass an oral examination covering the general field of entomology.

In addition to satisfying the general Graduate College requirements, candidates for the degree of Doctor of Philosophy in Entomology must pass the reading

examination in a second foreign language not later than the end of their third semester of graduate study. They must have satisfied the department course requirements for the master's degree and must also earn one unit of credit in insect bionomics and one unit in insect taxonomy. The remainder of their program is made up of electives with due attention to satisfying the requirements in regard to major and minor fields of specialization.

There are four chief fields of specialization in the department: general entomology (including morphology and taxonomy), insect bionomics, applied entomology (including economic entomology, medical entomology, and toxicology of insecticides), and insect physiology. The department is well equipped to offer work in these areas, and the facilities of the State Natural History Survey are also available for advanced study. Outstanding entomological library facilities are located on the campus.

The requirements of the Department of Entomology in regard to minors are the following: If a sole minor is elected, it must involve four units outside the department in one of the following areas: agronomy, bacteriology, botany (including plant pathology), chemistry, horticulture, physiology, and zoology. A first minor (two units) may be taken in a field of specialization in entomology other than the major, and the second minor (two units) must be in a related subject outside the department. For minors outside the Department of Entomology, the candidate should in all cases check the requirements both with his adviser and with the department concerned.

Doctoral candidates must pass an oral preliminary examination before entering the last year of residence. At the preliminary examination a candidate must exhibit a broad background in the whole field of entomology and a knowledge of general biological principles. A final oral examination is given after an acceptable thesis has been completed. At the option of the faculty, written examinations may also be required.

Theses required for the master's and doctor's degrees are due in the office of the Department of Entomology ten days before the date of the oral examination.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in entomology may be obtained from the head of the department, 100c Harker Hall.

GRADUATE TEACHING FACULTY

Professors: L. E. Chadwick (Head of Department), G. C. Decker, W. L. Downes, Jr., G. S. Fraenkel, W. R. Horsfall, C. W. Kearns, H. H. Ross, R. B. Selander.

Assistant Professor: J. G. Sternburg.

COURSES FOR GRADUATES

410. **Insect Morphology.** A comprehensive study of the internal and external structure of insects, from the comparative viewpoint. II; 1 unit. Prerequisite: Entomology 301. Sternburg.

412. **Structural Evolution of Insects.** An intensive study of the evolution of insect form and function, including individual research on selected problems. I; 1 unit. Prerequisite: Entomology 410. Chadwick.

413. **Medical and Veterinary Entomology.** Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of disease among men and domestic animals. I; 1 unit. Prerequisite: Entomology 101, 103, or 301; or Zoology 320. Horsfall.

420. **Chemistry and Toxicology of Insecticides.** Designed to provide the funda-

mental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. II; 1 unit. Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. KEARNS, STERNBURG.

422. **Insect Physiology.** A study of the principal physiological and biochemical functions of insects, exclusive of sensory functions. II; 1 unit. Prerequisite: Entomology 301; a course in organic chemistry. FRAENKEL.

423. **Insect Behavior.** An analysis of the physiological basis of insect behavior, including a thorough study of the physiology of the various sensory systems. I; 1 unit. Prerequisite: Entomology 301. CHADWICK, FRAENKEL.

426. **Seminar in Entomology.** Discussions, reviews, and appraisals of special topics in the field of entomology. I, II; ¼ to 1 unit. Prerequisite: Entomology 302; consent of instructor. CHADWICK, DECKER, DOWNES, FRAENKEL, HORSFALL, KEARNS, ROSS, SELANDER, STERNBURG.

499. **Thesis Research.** Work may be taken in the following subjects: morphology and embryology of insects, applied entomology, systematic entomology, biology and ecology of insects, insect physiology. I, II; 0 to 4 units. CHADWICK, DECKER, DOWNES, FRAENKEL, HORSFALL, KEARNS, ROSS, SELANDER, STERNBURG.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Advanced Entomology, I.** With Entomology 302, this course provides the necessary background for all further advanced work in the department. Entomology 301 is devoted to integrated studies of the principal morphological and physiological characteristics of insects, and is to be followed by similar taxonomic studies in Entomology 302. I; 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalents. CHADWICK, FRAENKEL, STERNBURG.

302. **Introduction to Advanced Entomology, II.** With Entomology 301, this course provides the necessary background for all further advanced work in the department. Entomology 302 completes studies of the principal morphological and physiological characteristics of insects, begun in Entomology 301, outlines the principles of systematic entomology, and presents the criteria for the classification of the insect orders. II; 1 unit. Prerequisite: Entomology 301. CHADWICK, FRAENKEL, SELANDER, STERNBURG.

306. **Special Problems.** For students ready to take up some special investigation which may be completed as an undergraduate study or the beginning of a thesis problem for an advanced degree. May also be used to prepare a thesis for scholastic honors. I, II; ¼ to 1 unit. Prerequisite: Any of the following: Entomology 131, 301, 302, 317, 319, 322, or Zoology 101 or 321; senior standing. CHADWICK, DECKER, DOWNES, FRAENKEL, HORSFALL, KEARNS, ROSS, SELANDER, STERNBURG.

312. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelations with other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent. STERNBURG.

317. **Classification of Insects.** Presentation of the distinctive structural features of the principal families of insects. I; 1 unit. Prerequisite: Entomology 302. SELANDER.

319. **Fundamentals of Insect Control.** The course emphasizes the principles that underlie effective control practices, rather than the details of methods used against specific pests. Both environmental and chemical factors involved in insect control are considered from their basic aspects. I; 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalents. HORSFALL, KEARNS, STERNBURG.

322. **Insect Bionomics.** This phase of the biology of insect deals with life history and conditions of environment that favor abundance of insects representative of various habitats. II; 1 unit. Prerequisite: Entomology 101, 103, or 301, or Zoology 320. HORSFALL.

FINANCE

The Department of Finance offers graduate work as a major or minor for the Master of Science degree and as a minor for the Doctor of Philosophy degree. The following fields are available for specialization within the department: central banking history and policy, corporation finance, investment, insurance, and urban land utilization.

A candidate for the Master of Science degree with a major in finance must have a grade-point average of at least 3.5 and must meet the general requirements of the Graduate College for admission as described in the introductory section of this bulletin. He must also have had (1) at least twenty-seven hours of undergraduate work in social science, fifteen hours of which must have been in economics, including a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

A candidate who elects finance as a minor for either the master's degree or the doctorate must have had (1) at least twelve hours of undergraduate work in social science, eight hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

One year of graduate study in economic theory and a thesis are required as part of the minimum eight units for the master's degree in finance.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in finance may be obtained from the head of the department, 311 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professors: P. M. VAN ARSDELL (Head of Department), R. W. MAYER, R. I. MEHR, R. M. NOLEN, R. C. OSBORN, C. A. PHILLIPS.
Associate Professor: R. O. HARVEY.
Assistant Professor: R. A. HEDGES.

COURSES FOR GRADUATES

420. **Central Banking Policy.** An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. I, II; 1 unit. NOLEN.

454. **Corporation Finance.** Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts

of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. I; 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

455. **Corporation Finance.** Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. II; 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

456. **Investment.** A study of the financial process by which savings are transformed into capital with emphasis on the theory of investment, on a critique of investment policy, and on the valuation of investment media. I; 1 unit. MAYER.

460. **Theory of Insurance.** A study of the nature and cost of risk in our society and of the methods of handling it. I, II; 1 unit. MEHR.

490. **Individual Study and Research.** Directed reading and research. I, II; ½ to 1 unit. STAFF.

499. **Thesis Research.** Required for those writing master's theses in finance. I, II; 0 to 2 units. MAYER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

359. **Security Analysis.** Application of investment principles to investment policy; analytical principles and techniques; analysis of fixed income corporate securities, of senior securities with speculative features, of common stocks, of government and municipal securities, and of investment company securities. II; ½ to 1 unit. Prerequisite: Accountancy 108; Finance 254. MAYER.

360. **Group Insurance and Pensions.** Same as Labor and Industrial Relations 360. A study of the problems faced by management and labor in establishing employee benefit plans for death, disability, and retirement. Actual case problems are used in the course. I; ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Management 248. MEHR.

363. **Advanced Life Insurance.** A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. II; ½ to 1 unit. Prerequisite: Finance 262. MEHR.

366. **Casualty Insurance.** An examination of hazards, contracts, forms, rates, underwriting principles, and loss prevention activities in the following branches of insurance: workman's compensation, public liability, burglary, robbery, theft, glass, power plant, credit, accident and health, and fidelity and surety. I; ½ to 1 unit. Prerequisite: Finance 260. HEDGES.

367. **Problems in Insurance.** An analysis of problems dealing with the fitting of insurance coverages to the needs of business. The course considers the problems of surveying hazards, selecting policy forms, rating, underwriting, loss adjustment, loss prevention, and over-all insurance planning. II; ½ to 1 unit. Prerequisite: Finance 263 and 366. HEDGES, MEHR.

368. **Survey of Urban Real Estate.** A broad survey of the field of real estate land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. I; ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor. HARVEY.

369. **Urban Land Problems.** A problems course for students interested in undertaking detailed analysis of urban land problems. Problems are selected for

individual study. Whenever possible the problems are selected and developed jointly with the Departments of City Planning and Landscape Architecture, Architecture, and others. II; ½ to 1 unit. Prerequisite: Finance 368 or consent of instructor. HARVEY.

FOOD TECHNOLOGY

(Including Dairy Technology)

The Department of Food Technology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in either Food Technology or Dairy Technology. Students undertaking graduate work in either field must have a grade-point average of at least 3.5 in the last half of undergraduate work.

Minors may be selected from the fields of physical, biological, agricultural, or engineering science, economics, or management. Candidates for the degree of Doctor of Philosophy should complete formal course work and satisfy the language requirements (German and French or Spanish) by the end of the second year of residence so that a minimum of one year may be spent in research. Each candidate must take a comprehensive written examination before the oral preliminary examination for the doctorate.

Graduate credit courses offered outside the Department of Food Technology may be applied in partial satisfaction of the major unit requirements. These may be selected from closely related fields of study, such as bacteriology, chemistry, physics, engineering, and applied biological sciences, and are subject to the approval of the major department.

A student planning to take a major or minor in dairy technology should have had previous training as an undergraduate in this field. It is also desirable for the student to have had a course in statistics, advanced undergraduate training in mathematics and chemistry, and at least a year of French, Spanish, or German.

To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350, Dairy Technology 401 (one unit), 404 (one unit), and 499 (two units). A course in statistics is also necessary unless such a course was taken by the student when an undergraduate. The remainder of the eight units required for the Master of Science degree can be taken in the major and minor fields.

Second-year and third-year graduate students are expected to attend all seminars (Dairy Technology 404) in dairy technology, but they can register for a maximum of only one unit of credit.

A student planning to take a major or minor in food technology should have a Bachelor of Science degree in a recognized field of biological, physical, agricultural, or engineering science in which a minimum of the undergraduate credits are as follows: biology, six hours; physics, eight hours; calculus, five hours; bacteriology, five hours; analytical chemistry, five hours; organic chemistry, five hours; physical chemistry, four hours; and food technology or equivalent, twenty hours. Deficiencies in any of these requirements may be made up during the first year of graduate study, but no graduate credit is given.

To obtain a graduate degree in food technology, a student must have credit (graduate or undergraduate) in Bacteriology 308, Chemistry 350, and Food Technology 301, 302, 421 (M.S., one-half unit; Ph.D., one unit), and 499 (M.S., two units; Ph.D., eight units).

Research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing.

Candidates for the master's degree must complete one language requirement (German, French, or Spanish) and one minor and are required to take an examination covering the field of general food technology and of their specialization. This is primarily an oral examination although at the option of the faculty it

may include a written section. The candidate must present a thesis unless this requirement is waived by petition to the department.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in food technology may be obtained from the Department of Food Technology, 213 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: R. T. Milner (Head of Department), E. O. Herreid, L. B. Howard, A. I. Nelson, Z. J. Ordal, P. H. Tracy, S. L. Tuckey.
Associate Professors: F. A. Kummerow, R. M. Whitney.
Assistant Professors: M. P. Steinberg, J. Tobias, L. D. Witter.

Food Technology

COURSES FOR GRADUATES

404. **The Technology of Fats and Oils.** Lectures, reference readings, and demonstrations on the factors involving the technology of fats and oils. II; ½ unit. Prerequisite: Food Technology 391. Kummerow.

406. **The Technology of Fats and Oils.** Laboratory, reference readings, and demonstrations on the factors involving the technology of fats and oils. II; ½ unit. Prerequisite: Credit or registration in Food Technology 404. Kummerow.

421. **Seminar.** Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food technology. I, II; ½ unit. Staff.

430. **Carbohydrates in Foods.** Same as Home Economics 430. A study of the physical and chemical properties of carbohydrates used in foods and their behavior under conditions encountered in food processing and storage. I; ¾ unit. Prerequisite: Chemistry 350 or consent of instructor. Osman.

481. **Advanced Studies in Food Technology.** Library or laboratory assignments on specific problems of limited scope involving individual commodities or processes. I, II; ½ to 2 units. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, and dehydrating. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. I; 1 unit. Prerequisite: Food Technology 201 and 260, or equivalent. Nelson.

302. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats and poultry products; and vacuum and freeze drying of foods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. II; 1 unit. Prerequisite: Food Technology 202 and 301, or equivalent. Nelson.

332. **Principles of Sanitation in the Processing and Handling of Foods.** Same as Veterinary Pathology and Hygiene 332. A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to

various food processing industries. Control of insects, rodents, and microorganisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulations. Local field trips to food processing plants. II; ½ unit. Prerequisite: Bacteriology 104 and Chemistry 132, or equivalent. ORDAL, WITTER.

363. **Introduction to Process Engineering.** Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food technology; not open to majors in chemical engineering. Lectures and problems. I; ¾ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Chemistry 340 and 341 or 342; one year of calculus.

373. **Advanced Food Microbiology.** A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. I; 1¼ units. Offered in 1959-1960 and in alternate years. Prerequisite: Bacteriology 308 and Chemistry 133, or equivalent. ORDAL, WITTER.

391. **The Technology of Fats and Oils.** Lectures, reference readings, and demonstrations on the factors involving the technology of fats and oils. I; ½ unit. Prerequisite: Credit or registration in Chemistry 350 or consent of instructor. KUMMEROW.

393. **The Technology of Fats and Oils.** Laboratory exercises and demonstrations of factors involving the technology of fats and oils. I; ½ unit. Prerequisite: Credit or registration in Food Technology 391. KUMMEROW.

Dairy Technology

COURSES FOR GRADUATES

401. **Advanced Principles of Dairy Technology.** Study of fundamentals and fundamental problems involved in the processing of milk and milk products. S; 1 unit. Offered in 1959 and in alternate years. Prerequisite: Chemistry 350. HERREID.

403. **Colloid Phenomena of Dairy and Other Food Products.** A study of the colloidal phenomena involved in the processing of dairy and other food products. S; 1 unit. Offered in 1960 and in alternate years. Prerequisite: Chemistry 249 or consent of instructor. WHITNEY.

404. **Seminar.** Review of current literature in dairy technology. Students may register for credit only twice for a maximum of one unit. I, II; 0 to ½ unit. TRACY.

491. **Assigned Problems in Dairy Technology.** Research on special problems for graduate students with a major interest in dairy technology. I, II; ½ to 2 units. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Plant Management.** Problems in the organization, financing, labor management, and operation of dairy plants. II; ½ unit. TRACY.

310. **Dairy Product Processing.** Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, and ice cream. II; 1 unit. Prerequisite: Dairy Technology 101 and 211; credit or registration in Dairy Technology 213. HERREID.

311. **Dairy Product Processing.** Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter,

butter oil, cheese, dried milk, casein, lactic acid, lactose, and fermentation products of whey. I; 1 unit. Prerequisite: Dairy Technology 211 and 213. TUCKEY.

312. **The Chemistry of Milk and Milk Products.** Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. I; ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 213 or Chemistry 122. WHITNEY.

FRENCH

(Including Russian)

The Department of French offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Students with a minimum grade-point average of 3.5 are regularly admitted to graduate courses in French, subject to fulfillment of other prerequisites.

Students electing French as a major subject should have had the equivalent of at least four years of French in college, including practical work in the use of the language and an advanced course in literature. Some knowledge of other Romance languages and literatures is desirable. A basic knowledge of Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Degree of Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates for the degree of Master of Arts in French must pass an examination based on a general reading list. Candidates preparing to teach French take French 407, 409, 410 unless they can demonstrate proficiency.

Degree of Doctor of Philosophy in French. Candidates for this degree are required to include French 475 and 476, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject.

Degree of Master of Arts in the Teaching of French. Candidates for the degree of Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 407, 409, 410, two units; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields. The adviser for candidates for this degree is Professor J. F. Jackson, 226 Lincoln Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in French may be obtained from the head of the department, 234 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: C. A. KNUDSON (Head of Department), J. E. EHRHARD, J. F. JACKSON, P. E. JACOB, P. KOLB, J. R. SMILEY, P. A. WADSWORTH.
Associate Professor: C. P. VIENS.
Assistant Professors: R. E. HALLOWELL, FRANCES F. SOBOTKA.

COURSES FOR GRADUATES

400. **Beginning French for Graduate Students.** Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing

for the French reading requirements for the Ph.D. degree. I, II; 4 hours. No graduate credit.

401. **Reading French for Graduate Students.** Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. degree. I, II; 4 hours. No graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

407. **Advanced French Diction.** Training in the improvement of French pronunciation, with special attention to the problems of teachers. It is recommended that this course and French 409 be taken simultaneously. I; ½ unit. EHRHARD, VIENS.

409. **The Phonetics of French.** A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 407 be taken simultaneously. I; ½ unit. KNUDSON.

410. **Advanced Syntax.** An advanced theoretical and practical study of present-day French, with some consideration of stylistics. Conducted in French. II; 1 unit. EHRHARD, VIENS.

424. **Studies in French Poetry.** Versification, poetic structure, problems of imagery and meaning, and practical work in the interpretation of individual poems. S; 1 unit. WADSWORTH.

425. **Explication de textes, I.** Exercises according to the method of *explication de textes,* applied to texts selected principally from the period 1944-1958. I; 1 unit. EHRHARD.

426. **Explication de textes, II.** The French method of *explication de textes* applied to selected texts of the principal French writers, in particular the *penseurs et essayistes.* II; 1 unit. EHRHARD.

431. **History of Old French Literature, I.** Lectures on the history of French literature from the eleventh through the thirteenth century, with particular attention to epic and romance. Illustrative reading in translation. I; ½ unit. Offered in 1958-1959 and in alternate years. KNUDSON.

432. **History of Old French Literature, II.** II; ½ unit. Offered in 1958-1959 and in alternate years. Knudson.

433. **Villon, Rabelais.** I; 1 unit.

434. **Montaigne, La Pléiade.** II; 1 unit.

435. **Seventeenth Century Literature, I.** I; 1 unit. Offered in 1959-1960 and in alternate years. WADSWORTH.

436. **Seventeenth Century Literature, II.** II; 1 unit. Offered in 1959-1960 and in alternate years. WADSWORTH.

437. **Eighteenth Century Literature, I.** I; 1 unit. Offered in 1958-1959 and in alternate years. WADSWORTH.

438. **Eighteenth Century Literature, II.** II; 1 unit. Offered in 1958-1959 and in alternate years. WADSWORTH.

447. **Nineteenth Century Literature to 1850, I.** I; 1 unit. Offered in 1958-1959 and in alternate years. JACKSON.

448. **Nineteenth Century Literature to 1850, II.** II; 1 unit. Offered in 1958-1959 and in alternate years. JACKSON.

453. **French Realism and Naturalism, I.** I; 1 unit. Offered in 1959-1960 and in alternate years. JACKSON.

454. **French Realism and Naturalism, II.** II; 1 unit. Offered in 1959-1960 and in alternate years. JACKSON.

457. **Seminar in Proust, I.** I; ½ unit. Offered in 1959-1960 and in alternate years. KOLB.

458. **Seminar in Proust, II.** II; ½ unit. Offered in 1959-1960 and in alternate years. Kolb.

465. **La Littérature Contemporaine, I.** In French. Poetry. Baudelaire; symbolism up to Valéry. Prose writers from 1900 to 1940. I; 1 unit. Offered in 1958-1959 and in alternate years. Jacob.

466. **La Littérature Contemporaine, II.** II; 1 unit. Offered in 1958-1959 and in alternate years. Jacob.

475. **Old French Philology, I.** Reading of characteristic masterpieces of medieval French literature and study of the development of the Old French language from Latin. I; 1 to 1¼ units. Offered in 1958-1959 and in alternate years. Prerequisite: Consent of instructor; elementary knowledge of Latin; reading knowledge of German. Knudson.

476. **Old French Philology, II.** II; 1 to 1¼ units. Offered in 1958-1959 and in alternate years. Prerequisite: French 475. Knudson.

491. **Individual Topics.** I, II; ¼ to 2 units. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The prerequisite for all courses in this group is French 201 and 202, or equivalent.

309. **Survey of French Literature, I.** I; ¾ unit. Jackson.

310. **Survey of French Literature, II.** II; ¾ unit. Jackson.

317. **Modern French Drama, I.** I; ½ unit. Offered in 1958-1959 and in alternate years. Viens.

318. **Modern French Drama, II.** II; ½ unit. Offered in 1958-1959 and in alternate years. Viens.

323. **French Drama of the Seventeenth and Eighteenth Centuries, I.** I; ¾ unit. Offered in 1959-1960 and in alternate years. Kolb.

324. **French Drama of the Seventeenth and Eighteenth Centuries, II.** II; ¾ unit. Offered in 1959-1960 and in alternate years. Kolb.

331. **French Novel of the Nineteenth Century, I.** From Balzac to Proust. I; ¾ unit. Offered in 1958-1959 and in alternate years. Jacob.

332. **French Novel of the Nineteenth Century, II.** From Balzac to Proust. II; ¾ unit. Offered in 1958-1959 and in alternate years.

333. **La Littérature Contemporaine, I.** In French. Modern poetry from Baudelaire to Valéry. Prose writers from 1900 to 1940. I; ½ unit. Offered in 1959-1960 and in alternate years. Jacob.

334. **La Littérature Contemporaine, II.** II; ½ unit. Offered in 1959-1960 and in alternate years. Jacob.

Russian

COURSES FOR GRADUATES

400. **Beginning Russian for Graduate Students.** Basic grammar and vocabulary, introduction to the reading of Russian texts in the sciences and the humanities. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. degree. II; 4 hours. No graduate credit.

401. **Readings in Russian for Graduate Students.** Grammar, vocabulary, general and special readings. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. degree. I; 4 hours. No graduate credit. Prerequisite: Russian 400 or equivalent.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Reading of Expository Prose, I.** Reading and translation of graded material in the fields of history, criticism, sociology, and the sciences. I; 1 unit. Prerequisite: Russian 102 and senior standing, or consent of instructor. SOBOTKA.

306. **Reading of Expository Prose, II.** Supervised individual reading programs. Designed for students majoring or minoring in Russian, or who desire to achieve competence in reading Russian for other subject fields; and as a terminal course for graduate students offering Russian in fulfillment of the language requirement for an advanced degree. II; 1 unit. Prerequisite: Russian 305 or consent of instructor. SOBOTKA.

309. **Survey of Russian Literature, I.** Survey of Russian literature from the end of the eighteenth century to the present day; cultural and historical background of the period. No knowledge of Russian language is required. I; ¾ unit.

310. **Survey of Russian Literature, II.** Survey of Russian literature from the end of the eighteenth century to the present day; cultural and historical background of the period. No knowledge of Russian language is required. II; ¾ unit.

321. **Readings in Russian Literature: Pushkin, Lermontov, Gogol.** Representative works of the period 1820-1850. Historical and cultural backgrounds. I; ¾ to 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Russian 104 or consent of instructor. SOBOTKA.

322. **Readings in Russian Literature: Turgenev, Tolstoy, Dostoyevski.** Representative works of the period 1850-1880. Historical and cultural backgrounds. II; ¾ to 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Russian 321 or consent of instructor. SOBOTKA.

323. **Readings in Russian Literature: Goncharov, Ostrovsky, Tolstoy.** Representative novels and plays of the later nineteenth century. Historical and cultural backgrounds. I; ¾ to 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Russian 104 or consent of instructor. SOBOTKA.

324. **Readings in Russian Literature: Chekhov, Gorky.** Representative novels and plays of the period 1886-1917. Historical and cultural backgrounds. The final weeks of the course are an introduction to contemporary literature. II; ¾ to 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Russian 323 or consent of instructor. SOBOTKA.

GENETICS

Students desiring a general training in genetics may take a major or minor in botany or zoology. Those desiring to approach agricultural problems through genetics may take a major or minor in agronomy, horticulture, animal science, or dairy science. For courses in the subject, see the Departments of Agronomy, Animal Science, Bacteriology, Botany, Dairy Science, Horticulture, and Zoology. An interdepartmental genetics seminar is held at frequent intervals. Consult the University's weekly calendar for time and place.

GEOGRAPHY

The Department of Geography offers graduate work leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy. The following fields of geography are available for specialization in graduate study: climatology,

economic geography, cartography, land utilization, conservation of resources, regional geography, political geography, historical geography, and educational geography.

Students applying for admission must have a 3.75 grade-point average. All candidates for advanced degrees in geography must have an average of at least 4.0 in previous work in geography.

Degree of Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose background is largely in physical geography are recommended for the degree of Master of Science; others receive the degree of Master of Arts. The program leading to the master's degree in geography is to add breadth to the student's geographic knowledge and to introduce the student to semi-independent accumulation and use of the geographic materials in seminars, and to independent research and advanced study. Adequate latitude in course requirements is provided to allow the candidate to complete his understanding of the broad aspects of geography (depending on his undergraduate concentration) and to begin to penetrate more deeply into specific phases of geographic content. In this way the master's degree can either be a terminal degree or lead directly into the more intensive study toward the doctorate.

At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. In individual cases, additional units of work may be required by the departmental graduate committee. Students must have had, either as an undergraduate or as a graduate, training in climatology, map construction and map reading and interpretation, introductory field work, cultural geography, and regional geography. They must also have proficiency equivalent to that expected of an Illinois undergraduate major in a physical or biological science, in a social science, in statistical method, and in oral and written expression. Geology, botany, soils, or zoology are recommended as physical or biological sciences; economics, history, political science, sociology, or anthropology are recommended in the social sciences.

Degree of Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are electives, two units in education, and two units in electives. Requirements are Geography 493, one unit; Geography 495, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in geography and the other electives must be selected with the approval of the adviser. Two electives must be in geography and the other two in geography, education, or, in exceptional cases, other fields. The grade-point average required for admission is the same as required by the department. The adviser for candidates for this degree is Professor J. H. Garland, 248 Natural History Building.

Degree of Doctor of Philosophy. The doctoral program presupposes an understanding of geographic patterns. This program is, therefore, intended to increase the student's ability to use his knowledge of geography and its allied fields and to provide maximum opportunity for the exercise of independent ability. The doctoral student is expected to penetrate deeply into the content, techniques, implications, and significance of specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world.

Candidates for the degree of Doctor of Philosophy in Geography must have taken, either as an undergraduate or as a graduate, all work or the equivalent which is required in the undergraduate major and the master's and doctor's programs of the department. Eight of the minimum twenty-four units of graduate credit required for the Doctor of Philosophy degree must be in Geography 499 and are devoted to the completion of an original and independent doctoral thesis. Geography 499 is carried subsequent to the admission of the student to candidacy for the degree.

The work required for a Doctor of Philosophy degree in geography is divided into two phases, first, that of preparing a student for formal admission to candidacy for the degree, and second, the satisfactory completion of the doctor's thesis and the support of the thesis in an examination.

Admission to candidacy for the Doctor of Philosophy degree in geography is recommended after the successful completion of the following requirements:

(1) At least sixteen units of graduate credit, or equivalent, including four units in official minor fields. At least nine of these sixteen units must be in geography. The department recommends a split minor, consisting of at least two units in each field. One of the minors should be in geology, botany, soils, or zoology, the other in economics, history, political science, or sociology and anthropology. Other minor fields may be accepted upon recommendation of the major adviser.

(2) The required examinations in foreign languages.

(3) A preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College. The examination covers selected divisions of physical, cultural, and regional geography, the techniques and theory of the discipline, and the student's minor fields.

After being admitted to candidacy for the Doctor of Philosophy degree, the student must complete a research thesis which demonstrates his capacity to complete and to support independent and original work in geography. The doctoral thesis normally requires field investigation.

Additional information concerning the requirements of the department may be obtained from the head of the department.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in geography may be obtained from the head of the department, 220 Davenport Hall.

GRADUATE TEACHING FACULTY

Professors: J. A. Russell (Head of Department), A. W. Booth, F. W. Foster, J. H. Garland, J. L. Page.
Associate Professors: R. L. Carmin, J. D. Fellmann.
Assistant Professors: C. S. Alexander, H. G. Roepke.

COURSES FOR GRADUATES

412. **Analytical Climatology.** A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. II; 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Page.

421. **Regional Concepts in Geography.** Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. II; ½ unit. Prerequisite: Nine hours of regional geography. Garland.

441. **Fundamentals of Bioclimatology.** Same as Physiology 441. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological and pathophysiological processes in mammals, and the application of meteorological, climatological, and geographical techniques in physiological studies. I or II; ¾ unit. Prerequisite: Consent of instructor. Page, Sargent.

442. **Experimental Bioclimatology.** Same as Physiology 442. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. I or II; ½ unit.

Prerequisite: Physiology 306 and 307; credit or registration in Geography 441. PAGE, SARGENT.

443. **Advanced Human Bioclimatology.** Same as Physiology 443. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. I or II; ½ unit. Prerequisite: Geography 441. PAGE, SARGENT.

463. **Historical Geography.** Objectives and methods of historical geography. II; 1 unit. FELLMANN.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. II; 1 unit. Prerequisite: Geography 373 or consent of instructor. FOSTER.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. I; 1 unit. FOSTER.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. STAFF.

495. **Advanced Studies in Geography.** Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. I, II; ½ to 2 units. Work may be taken in the following fields:

(a) **Anglo-America.** GARLAND.
(b) **Latin America.** CARMIN.
(c) **Europe.** FOSTER, ROEPKE.
(d) **Asia.** BOOTH, RUSSELL.
(e) **U.S.S.R.** FELLMANN.
(f) **Australia and Oceania.** RUSSELL.
(g) **Economic Geography.** ROEPKE, RUSSELL.
(h) **Political Geography.** GARLAND.
(i) **Urban Geography.** CARMIN, FELLMANN.
(j) **Physical Geography.** BOOTH.
(k) **Mathematical Geography.** BOOTH.
(l) **Land Utilization and Conservation.** BOOTH, FOSTER, ROEPKE, RUSSELL.
(m) **Transportation Geography.** BOOTH, FELLMANN, FOSTER.
(n) **Problems of Geographic Study.** STAFF.

497. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. I; ½ unit. FELLMANN.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

313. **Climates of the Continents.** A regional treatment of the climates of the world by continents. I; ½ unit. Prerequisite: Geography 101 and 111. PAGE.

314. **Regional Problems in Conservation of Natural Resources.** The distribution, use, and interrelationship of the resources in the various resource management regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. II; ½ unit. Prerequisite: A previous course in conservation, or workshop or field work training in conservation. BOOTH.

332. **Geography of South America.** A regional geography of South America with

emphasis on the southern hemisphere of that continent. II; ½ unit. Prerequisite; Eight hours of geography or enrollment in Latin-American studies program. CARMIN.

342. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. II; ½ unit. Prerequisite: Eight hours of geography. FOSTER.

350. **Geography of World Islands Including Australia.** Physical and cultural landscapes of Australia and the major island groups as habitats for man. II; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

351. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. I; ½ unit. Prerequisite: Eight hours of geography. BOOTH.

353. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and transportation. I; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. FELLMANN.

355. **Geography of Central and South Africa.** A regional geography of Africa south of the Sahara. I; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

361. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. II; ½ unit. Prerequisite: One course in geography or enrollment in the College of Agriculture. ROEPKE.

362. **Manufacturing Regions of the World.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. I; ½ unit. Prerequisite: One course in geography, or enrollment in the College of Commerce and Business Administration, or enrollment in the College of Engineering. ROEPKE.

363. **Production of Great World Minerals.** Geographic aspects of the mineral industries. II; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Eight hours of geography. ROEPKE.

365. **Geographic Aspects of Transportation.** Geographic factors influencing transportation by land, sea, and air. II; ½ unit. Prerequisite: Eight hours of geography. BOOTH.

366. **Problems of Industrial Location.** The relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites. II; ½ unit. Prerequisite: Eight hours of geography. Three hours of economic geography for students in the College of Commerce and Business Administration. Engineering and architecture students may register with consent of instructor. RUSSELL.

371. **Introduction to Research.** Introductory training in the techniques and source materials of geographic research. Limited to students whose major is geography and to seniors whose major is in other departments but who have twelve hours of geography. I, II; ½ unit. FELLMANN and others.

372. **Introduction to Research.** Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. II; ½ unit. STAFF.

373. **Map Compilation and Construction.** Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. I, II; 1 unit. Prerequisite: Consent of instructor. FOSTER.

375. **Map Reading and Interpretation.** Evaluation of map components, map reading, map interpretation, map history, and survey of world maps and mapping. I; ½ unit. Prerequisite: Consent of instructor. CARMIN.

376. **Field Geography.** A study of the methods and techniques of field work in geography and the application of the procedures developed to field mapping problems in the Champaign-Urbana area. II; ½ unit. FOSTER.

378. **Descriptive Interpretation of Aerial Photographs.** Reading and interpreting of aerial photographs; their potentialities and limitations as a research tool of geography. II; ½ unit. Prerequisite: Consent of instructor. BOOTH.

383. **Urban Geography.** The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. II; 1 unit. Prerequisite: Eight hours of geography or consent of instructor. FELLMANN.

386. **Political Geography.** World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; western hemisphere nations. I; ½ unit. Prerequisite: Eight hours of geography. Major or graduate students in political science or history may enroll with consent of instructor. GARLAND.

GEOLOGY

Graduate students may take work in geology leading to the degrees of Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, economic geology, geomorphology and glacial geology, mineralogy and petrography, paleontology and stratigraphy, ground-water geology, and sedimentation.

Beginning graduate students in geology must have a grade-point average no lower than 3.75.

For graduate work in geology a student must have had (or take as a graduate student) undergraduate courses in physical geology, historical geology, mineralogy, geomorphology, structural geology, paleontology, stratigraphy, summer field course, chemistry, physics, and mathematics.

A candidate for the doctor's degree may select a minor in chemistry, physics, mining engineering, zoology, botany, agronomy, or geography. Other minors may be chosen with departmental approval.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in geology may be obtained from the head of the department, 234 Natural History Building.

In addition to University fellowships, industrial awards supported by the following companies are available to graduate students in geology.

The California Company has established a fellowship for graduate study in geology. The stipend is $1,500 for a year's study.

The Illinois Clay Products Company has established two fellowships for graduate study in the field of clay mineralogy. The stipend is $1,500 for a year's study.

A fellowship for graduate study in clay mineralogy has been established by the Baroid Sales Division of the National Lead Company. The stipend is $1,500 for a year's study.

A fellowship established by the Shell Fellowship Committee encourages graduate studies in the field of geology leading to a doctor's degree. The stipend is $1,800 for a year's study.

GRADUATE TEACHING FACULTY

Professors: G. W. White (Head of Department), C. A. Chapman, D. U. Deere, R. E. Grim, A. F. Hagner, J. L. Hough, G. B. Maxey, H. W. Scott, P. R. Shaffer, H. R. Wanless.

Associate Professors: A. Carozzi, D. M. Henderson.

Assistant Professor: F. L. Koucky.

COURSES FOR GRADUATES

401. **Advanced Dynamic Geology.** A study of geologic processes and their effects. II; 1 unit. Offered in 1959-1960 and in alternate years. Wanless.

402. **Advanced Historical Geology.** Principles of interpretation and problems of earth history. II; 1 unit. Offered in 1958-1959 and in alternate years. Wanless.

409. **Sedimentation.** II; 1 unit. Wanless.

415. **Geology of the Upper Mississippi Valley.** Field study of the geology of Illinois and adjacent states by means of five or six two-day field trips and the preparation of reports; estimated travel expense, $60. I; 1 unit. Wanless.

422. **Stratigraphic Geology: Paleozoic.** I; 1 unit. Prerequisite: Geology 321. Scott.

423. **Stratigraphic Geology: Mesozoic and Cenozoic.** II; 1 unit. Prerequisite: Geology 321.

425. **Micropaleontology: Foraminifera.** Classification of microfossils, foraminifera; stratigraphic correlation. I; 1 unit. Prerequisite: Geology 320 or Zoology 320. Scott.

426. **Micropaleontology: Ostracoda.** Classification of microfossils, ostracodes, conodonts, scolecodonts, and other major groups; stratigraphic correlations. II; 1 unit. Prerequisite: Geology 320 or Zoology 320. Scott.

435. **Igneous Petrology.** The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory a study is made of selected rock suites, and special methods of petrographical investigation are covered. I; 1 unit. Chapman.

436. **Metamorphic Petrology.** Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied and special methods of investigation are covered. II; 1 unit. Chapman.

437. **Sedimentary Petrology.** Study of the texture, composition, and structures of sedimentary rocks, with emphasis on laboratory methods of petrographical investigation; the classification of sedimentary rocks and a summary of the sedimentation portion of the petrologic cycle. I; 1 unit. Hough.

440. **Mineragraphy.** Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. I; 1 unit. Hagner.

443. **Mineral Deposits.** Principles of mineral deposition and genesis of mineral deposits. I; 1 unit. Prerequisite: Geology 311. HAGNER.

444. **Mineral Deposits.** Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. II; 1 unit. Prerequisite: Geology 443. HAGNER.

446. **Petroleum Geology: Principles.** I; 1 unit. Offered in 1959-1960 and in alternate years. HOUGH.

450. **Geology for Civil Engineers.** Advanced physical geology, with emphasis on the geological aspects of civil engineering. I; 1 unit. Prerequisite: Geology 150 or equivalent. DEERE.

461. **Mineralogy of Clays.** The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. I; 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

462. **Mineralogy of Clays.** The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. II; 1 unit. Prerequisite: Geology 461. GRIM.

493. **Advanced Studies in Geology.** I, II; ½ to 2 units. Work may be taken in the following fields:
   (a) **Clay Mineralogy.** GRIM.
   (b) **Engineering Geology.** DEERE, HOUGH.
   (c) **Geomorphology and Glacial Geology.** SHAFFER, WHITE.
   (d) **Ground-Water Geology.** MAXEY.
   (e) **Micropaleontology.** SCOTT.
   (f) **Mineral Deposits.** HAGNER.
   (g) **Mineralogy and Crystallography.** HENDERSON.
   (h) **Paleobotany.** (See Botany 493j). STEWART.
   (i) **Paleontology.** SCOTT.
   (j) **Pennsylvanian Stratigraphy.** WANLESS.
   (k) **Petrography and Petrology.** CHAPMAN.
   (l) **Sedimentary Petrology.** HOUGH, WANLESS.
   (m) **Stratigraphy.** SCOTT.

499. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Geomorphology.** The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. Lectures, laboratory, and field trips. I, II; 1 unit. Prerequisite: Geology 102. WHITE.

311. **Structural Geology.** Rock deformation and its results. Lectures, laboratory, and field trip. I, II; 1 unit. Prerequisite: Geology 102. CAROZZI.

315. **Field Methods.** Mapping of an area in southern Illinois or western Kentucky during Easter vacation. Credit is given only on completion of a satisfactory written report. II; ½ unit. Prerequisite: Geology 102. WANLESS.

316. **Field Geology.** Geology of the Baraboo, Wisconsin, region. Field course covering structural, stratigraphic, glacial, and physiographic features. Emphasis is on methods of study and interpretation. A comprehensive report is required to provide training in geological report writing. Credit is given only on completion of a satisfactory written report. S; 1 unit. Prerequisite: Geology 102 or equivalent; consent of instructor. HOUGH.

317. **Field Geology in the Rocky Mountains.** Field course conducted from a locality in the Rocky Mountains. Field training in stratigraphy, structure, and geomorphology; geologic mapping with plane table, and aerial photographs. Approximate cost, $250.00 to $305.00. S; 2 units. Prerequisite: Geology 102; consent of instructor. KOUCKY.

320. **Invertebrate Paleontology.** Fossil groups in biological sequence. Lectures and laboratory. I, II; 1 unit. Prerequisite: Geology 102.

321. **Stratigraphy.** Stratigraphy-fossil faunas, with special reference to invertebrates, correlation, and stratigraphy. I, II; 1 unit. Prerequisite: Geology 320. SCOTT.

324. **Vertebrate Paleontology.** Same as Zoology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. I; ½ unit. Prerequisite: Zoology 132 or Geology 102.

325. **Paleobotany.** Same as Botany 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. II; ½ or 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Geology 101 and Botany 100 or Division of General Studies 131 and 132; or consent of instructor. STEWART.

335. **Optical Mineralogy.** Study of the optical properties of minerals and the use of the petrographic microscope. Emphasis is on the identification of minerals by the immersion method. Designed for students in geology, ceramics, chemistry, mining, and agriculture. I; 1 unit. Prerequisite: Geology 132. CHAPMAN.

336. **Petrography.** Study of the constituents, composition, textures, structures, and classification of rocks. In the laboratory, rocks are studied in hand specimen and thin section. Emphasis is on the ordinary methods of petrographical investigation. II; 1 unit. Prerequisite: Geology 335. CHAPMAN.

351. **Geophysical Prospecting.** Same as Mining Engineering 351. Principles of geophysics and their application to mining processes. I; 1 unit. WUERKER.

354. **Mining Geology.** Same as Mining Engineering 354. Structure and occurrence of mineral deposits in relation to prospecting, exploration, development, and exploitation. II; 1 unit. Prerequisite: Geology 101 or 150, 130 or 131, and Mining Engineering 201 or 230; or consent of instructor. WRIGHT.

GERMAN

The Department of German offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Students applying for admission must have a 3.75 grade-point average. Students should have completed a four-year course of undergraduate study in German corresponding to the four-year course at this University. They should be familiar with the principal works of the writers of the classical and modern periods of German literature, possess a general knowledge in the history of German letters and civilization, and be able to follow lectures in the German language. Acquaintance with German history, philosophy, and art in their relation to the general European background is highly desirable. A reading knowledge of French is important and is required for advanced graduate work. Some fluency in Latin is also recommended.

Fields of concentration for advanced degrees include German philology and linguistics, older literature, and modern literature.

Candidates for the degree of Master of Arts in the Teaching of German must earn four units in German, two units in education, and two units in electives. Requirements are: German, two or two and one-half units to be chosen from

German 301, 302, 311, 312, 315, 320, 331, or 332; one and one-half to two units from German courses open only to graduates; education, two units, including two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives must be selected with the approval of the adviser. The adviser for candidates for this degree is Professor Mimi I. Jehle, 217 Lincoln Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in German may be obtained from the head of the department, 211 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: J. R. Frey, P. M. Mitchell, E. A. Philippson, H. Stegemeier.
Associate Professors: F. G. Banta (Chairman of Department), Mimi I. Jehle, F. J. Nock.

COURSES FOR GRADUATES

400. **Beginning German for Graduate Students.** Introduction to the reading of German texts in the sciences and the humanities. I, II; 4 hours. No graduate credit. Nock.

401. **Readings in German for Graduate Students.** Designed for graduate students preparing for the German reading requirements for the Ph.D. degree. I, II; 4 hours. No graduate credit. Prerequisite: German 400 or equivalent. Nock.

411. **Proseminar.** Methods of literary criticism and research. I or II; 1 unit. Staff.

415. **Middle High German.** I; 1 unit. Banta.

416. **History of the German Language.** II; 1 unit. Philippson.

426. **Gothic.** An introduction to Germanic (comparative) linguistics. II; 1 unit. Offered in 1959-1960 and in alternate years. Banta.

431. **German Literature of the Middle Ages.** German literature from 800 to 1400. I; 1 unit. Offered in 1959-1960 and in alternate years. Philippson.

432. **German Literature from 1400 to 1700.** Renaissance, Reformation, and Baroque in German literature. Lectures and readings. II; 1 unit. Offered in 1959-1960 and in alternate years. Philippson.

441. **German Romanticism.** I; 1 unit. Offered in 1959-1960 and in alternate years.

442. **Nineteenth Century German Realism.** II; 1 unit. Offered in 1959-1960 and in alternate years. Frey.

445. **Old High German.** Grammar and interpretation of the oldest literary documents. I or II; 1 unit. Offered in 1958-1959 and in alternate years. Philippson.

451. **Naturalism, Symbolism, Expressionism.** German literature from the 1880's to the 1920's. I; 1 unit. Offered in 1958-1959 and in alternate years. Frey.

452. **German Literature from the Twenties to the Present.** II; 1 unit. Offered in 1958-1959 and in alternate years. Frey.

460. **Seminar in German Literature.** Advanced research work in German literature; discussion of problems and papers. I or II; 1 unit. Staff.

493. **Research in Special Topics.** I, II; 1 to 4 units. Staff.

495. **Bibliography and Methods of Literary History.** To be taken concurrently with German 411. I or II; ½ unit. Frey.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **German Literature to 1700.** I; 1 unit. Prerequisite: Three years of college German or equivalent. FREY.

302. **German Literature Since 1700.** II; 1 unit. Prerequisite: Three years of college German or equivalent. FREY.

303. **Conversation, Composition, and Syntax.** Intensive study of advanced problems of grammar, syntax, and style. I; ½ unit. Prerequisite: Three years of college German including German 212, or consent of instructor. JEHLE.

311. **Goethe.** Introduction to Goethe's life and works. I; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Three years of college German. MITCHELL.

312. **Goethe's Faust.** Intensive study of Goethe's *Faust,* Parts I and II. II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Three years of college German or equivalent. MITCHELL.

320. **History of German Civilization.** A selected topical, historical, and pictorial analysis of German culture and civilization. I or II; 1 unit. Prerequisite: Three years of college German or equivalent. STEGEMEIER.

331. **The Age of Lessing.** I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Three years of college German or equivalent. FREY and others.

332. **Schiller.** II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Three years of college German or equivalent. STEGEMEIER and others.

360. **Introduction to German Phonetics.** I; ½ unit. NOCK.

363. **Introduction to Comparative Literature.** Same as English 363. A comparative study of great books in Greek, Roman, Italian, and Spanish literature. I; ½ unit. ALLEN, LANDIS.

364. **Introduction to Comparative Literature.** Same as English 364. A comparative study of great books in French, German, and English literature. II; ½ unit. JACOB, LANDIS.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs develops programs of training for the public service, provides in-service training for state and local government employees, holds institutes and conferences for citizens and public officials, and carries out a research program in the field of government and public affairs. The institute serves as a planning and directing agency to correlate the work of existing colleges and departments in the field of public affairs.

ASSISTANTSHIPS

The institute has available a limited number of part-time research assistantships for qualified students in the fields of political science, public administration, law, and economics. Applications should be addressed to the director, 1209 West Illinois Street.

HEALTH AND SAFETY EDUCATION

The Department of Health and Safety Education offers a program of graduate study leading to the degree of Master of Science in Health Education. This program is centered in training teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for training in the special fields of public health education, and safety education.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5; (2) thirty semester hours of approved undergraduate credit in health education or closely related courses; (3) twenty-four semester hours of approved undergraduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement.

Graduation requirements for this degree are eight units to include (1) four units in health education or approved courses in physical education; (2) two units in education, including two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit; (3) registration in and satisfactory completion of Health Education 490, no credit; (4) presentation of an acceptable thesis in health education, two units. Candidates may petition to waive the thesis and seminar requirements. Those who are excused are required to secure two units' credit in lieu of thesis credit and in addition are required to take and pass a final comprehensive written examination in health education.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in health and safety education may be obtained from the head of the department, 114 Huff Gymnasium.

GRADUATE TEACHING FACULTY

Professors: H. S. Hoyman (Head of Department), A. E. Florio, G. T. Stafford.
Associate Professors: F. E. Boys, G. B. Couch.
Assistant Professor: W. J. Huffman.
Lecturers: C. A. Bridger, I. M. Crawford, H. E. Hough, E. L. Wittenborn.

Health Education

COURSES FOR GRADUATES

400. **Scientific Foundations of Health Education.** Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and principles as these apply to the further improvement of personal, family, and community health. I or II; 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. Hoyman, Stafford.

401. **Problems in School Health Education.** History, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. I or II; 1 unit. Hoyman, Jackson, Stafford.

403. **Problems in Public Health.** Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. I or II; 1 unit. Stafford.

404. **Trends and Issues in Sex Education.** A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of philosophy, principles, methods, and current problems. I or II; 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, or consent of instructor. Hoyman.

490. **Seminar.** Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. I or II; no credit. Staff.

493. **Special Projects.** Individual research in school health and safety education. I, II; ½ to 1 unit. Prerequisite: Education 390, Physical Education 495, and Health Education 400, or equivalent. STAFF.

499. **Thesis Research.** Preparation of theses in health and safety education. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

390. **Public Health Education.** Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers. Projects in preparing and using public health education materials. Evaluation of research in public health education. I; ½ unit. Prerequisite: Consent of instructor. HOUGH, WITTENBORN.

391. **Public Health Statistics.** An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. II; ½ unit. Prerequisite: Mathematics 161 or Education 390, or equivalent. BRIDGER, CRAWFORD.

Safety Education

COURSES FOR GRADUATES

402. **Problems in Safety Education.** Philosophy of safety; traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. I or II; 1 unit. FLORIO, STAFFORD.

HISTORY

The Department of History offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Graduate work in history presupposes two years of college work in this subject, or sixteen semester hours, which should include courses in European and American history equivalent to History 111, 112, 151, and 152. Linguistic preparation, especially in French and German, is important. For ancient and medieval history some knowledge of Latin is essential. Spanish is useful for certain fields of American and Latin-American history. To be admitted to full standing in the Department of History, beginning graduate students must have a grade-point average no lower than 3.5.

Graduate courses in history at the University of Illinois are of three kinds: (1) lecture courses providing information, interpretation, and guidance in general reading; (2) instruction in methodology, historiography, and bibliography (History 495 and 496 are required of all graduate students in history during their first year); (3) seminars for the study of special fields with a view to training in methods of historical criticism and research and in the writing and presentation of historical essays.

Degree of Master of Arts. During his first term each candidate for this degree must demonstrate a satisfactory knowledge of history, such as would result from a sound undergraduate major program in the subject, by passing a comprehensive examination. Questions are given in the following four fields of history: ancient and medieval, modern European, English, and American. Candidates must answer questions in at least three of the four fields. Failure to pass the examination ordinarily results in the termination of candidacy for the degree, unless the

candidate satisfies special requirements justifying reinstatement. Each candidate is expected to devote special attention to two of the following fields: ancient history, medieval history of continental Europe, modern history of continental Europe, English history, American history, Latin-American history, and the history of the near East. Each candidate must write a master's thesis in one of his fields of specialization. To constitute a field of specialization a minimum of two units of graduate study is ordinarily required.

Graduate study in history may also be pursued in connection with the degrees of Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see page 250).

Degree of Doctor of Philosophy. The candidate who selects history as his major subject should prepare himself for a preliminary examination in five fields, of which four are normally in history and one is in an outside related subject.

The preparation of the candidate should include a minimum of four units in the field of history in which he wishes to specialize and in which his thesis is to be written. This field constitutes his major.

There should be a minimum of three units in a second field known as the first minor, and of two units each in three other fields. One of these, outside the department, constitutes the second minor.

The Department of History offers the following fields of specialization and preparation: ancient history, medieval history, continental Europe from 1300 to 1648 (Renaissance and Reformation), continental Europe and its dependencies since 1648, England and its dependencies, the United States, and Latin America. This enumeration of fields is not to be regarded as excluding the possibility of accepting others as may be determined by the department in individual cases.

The second minor field may be selected from the following departments and areas, although other suitable second minors may be arranged through consultation with department advisers:

Political Science. International law and diplomacy, modern government, municipal government, constitutional and administrative law and jurisprudence, political theory.

Economics and Sociology. Economic history, economic theory, public and private finance, social reform, principles of sociology.

Philosophy and Education. History of ancient and medieval philosophy, history of modern philosophy, history of education.

Literature. Some division of the history of literature, which may be either comparative literature of a limited period or the literature of a particular country for a more extended period as may be agreed upon in each case.

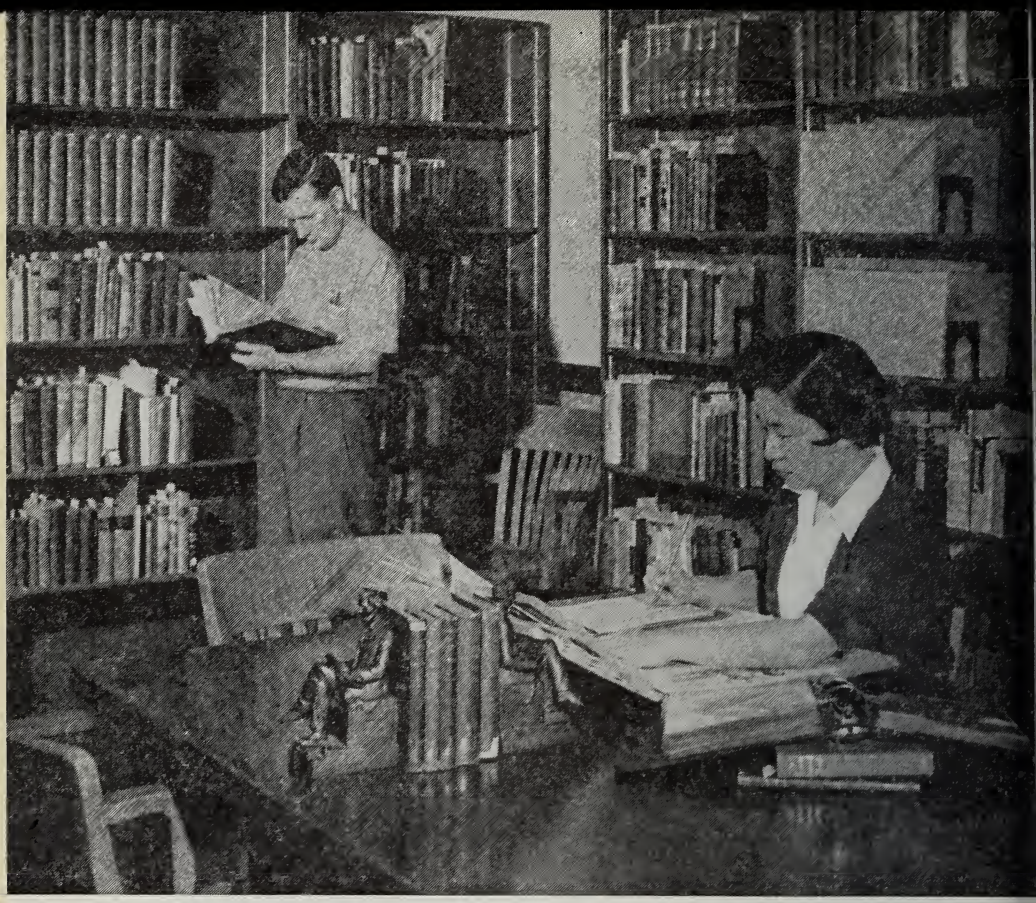
Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey, graduate students in the department are able to obtain useful training in the study of manuscript as well as printed materials.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor (three-unit field) in American literature, and the second minor (two-unit field) in the history of fine arts in the United States.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in history may be obtained from the head of the department, 325 Lincoln Hall.

In addition to University fellowships, the department awards annually to the ranking student in English or medieval history the Laurence M. Larson Fellowship, which represents the income from a fund of $5,000 set up in the will of Lillian D. Larson in memory of her husband, at one time head of the Depart-



The Lincoln Room of the University Library. This outstanding collection of material pertaining to the life and time of Abraham Lincoln is available for use by all students at the University of Illinois.

ment of History. The department participates with the Department of Political Science in the Kendric C. Babcock Fellowship established under the will of Dean Kendric C. Babcock. Nominations for these fellowships are made by the chairmen of the Departments of History and Political Science. Application forms may be obtained from the departmental offices.

GRADUATE TEACHING FACULTY

Professors: J. W. Swain (Chairman of Department), A. E. Bestor, E. L. Erickson, N. A. Graebner, C. E. Nowell, F. A. Shannon, C. G. Starr, R. P. Stearns.

Associate Professors: C. E. Dawn, D. J. Geanakoplos, B. D. Lyon, J. B. Sirich, R. M. Sutton.

Assistant Professors: J. L. Bates, Louise B. Dunbar, Mary L. Shay.

COURSES FOR GRADUATES

401. **Seminar in Medieval History.** Studies in the Crusades and the Early Renaissance. I, II; 1 unit. Geanakoplos.

409. **Early Modern Europe to 1815.** A graduate survey of problems and sources. I; 1 unit. Stearns.

410. **Modern Europe since 1815.** A graduate survey of problems and sources. II; 1 unit.

411. **The French Revolution and Napoleon.** A seminar in the history of France and her relations with Europe, 1789 to 1815. I or II; 1 unit. Sirich.

414. **Seminar in Modern History: The Enlightenment.** II; 1 unit. Stearns.

415. **Seminar in the History of Europe Since 1815.** I; 1 unit.

419. **Seminar in Modern Russian History.** I; 1 unit.

431. **Seminar in English History.** I; 1 unit. Erickson.

432. **Seminar in English History.** II; 1 unit. Lyon.

452. **Seminar in American History.** Introduction to research. I; 1 unit.

453. **Seminar in the Social History of the United States Before 1860.** I; 1 unit. Shannon.

454. **Seminar in the Social History of the United States Since 1860.** II; 1 unit. Shannon.

456. **Seminar in American Diplomatic History.** II; 1 unit. Graebner.

458. **Seminar in American History: The Revolutionary Period.** I, II; 1 unit. Dunbar.

472. **Seminar in the Intellectual and Constitutional History of the United States.** II; 1 unit. Bestor.

473. **Graduate Survey of American History to 1865.** I; 1 unit.

474. **Graduate Survey of American History Since 1865.** II; 1 unit.

476. **Seminar in Latin-American History: The Revolutionary Period.** Latin America during the first half of the nineteenth century. Research in special topics. II; 1 unit. Nowell.

482. **Seminar in Ancient History.** I; 1 unit. Swain.

495. **Historical Method.** Required of all candidates for an advanced degree in history who do not present evidence of similar training elsewhere. I; 1 unit. Bestor.

496. **History of Historiography.** Introduction to the great historians from early times to the present. II; 1 unit. Swain.

499. **Thesis Research.** Individual direction in research and guidance in writing theses for advanced degrees. I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **The Middle Ages from 400 to 1100 A.D.** Europe from the fall of Rome to the first crusade. I; ½ to 1 unit. GEANAKOPLOS.

302. **The Middle Ages from 1100 to 1500 A.D.** Europe from the rise of towns to the establishment of national monarchy. II; ½ to 1 unit. GEANAKOPLOS.

303. **History of Byzantine Civilization.** A study of the cultural, religious, and social history of the Eastern Roman Empire from Constantinople's foundation in 330 A.D., to the fall of Byzantium in 1453. Special attention is given to the continuation of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. I; ½ to 1 unit. GEANAKOPLOS.

304. **Medieval Civilization.** Religious and intellectual. II; ½ to 1 unit. GEANAKOPLOS.

305. **The Age of the Renaissance.** I; ½ to 1 unit. GEANAKOPLOS.

306. **The Age of the Protestant and Catholic Reformation, 1500 to 1648.** II; ½ to 1 unit. LYON.

307. **Classical Islam: The Near East from Mohammed to the Crusades.** I; ½ to 1 unit. DAWN.

308. **The Europeanization of the Near East, 1768 to 1914.** II; ½ to 1 unit. DAWN.

309. **Development of Modern Europe: Absolutism and Colonial Expansion, 1648 to 1789.** I; ½ to 1 unit. SIRICH.

310. **Development of Modern Europe: The French Revolution and Napoleon, 1789 to 1815.** II; ½ to 1 unit. SIRICH.

311. **Europe from 1815 to 1871.** I; ½ to 1 unit.

312. **Europe from 1871 to 1900.** II; ½ to 1 unit.

313. **European History from 1900 to 1929.** I; ½ to 1 unit. SHAY.

314. **European History from 1929 to the Present.** II; ½ to 1 unit. SHAY.

322. **History of Spain and Portugal.** A survey of the Iberian Peninsula from the earliest times until the present. I; ½ to 1 unit. NOWELL.

323. **Science, Philosophy, and the Modern European Mind.** Intellectual history of modern Europe from 1543 to 1770. I; ½ to 1 unit. SIRICH, STEARNS.

324. **Science, Idealism, and Materialism.** Intellectual history of modern Europe from 1770 to 1914. II; ½ to 1 unit. SIRICH, STEARNS.

326. **Intellectual and Cultural History of Russia from 1881 to the Present.** II; ½ to 1 unit.

327. **The Russian Revolution.** I; ½ to 1 unit.

328. **History of Soviet Russia from 1917 to the Present.** II; ½ to 1 unit.

333. **The Foundations of Modern England, 1377 to 1603.** I; ½ to 1 unit. LYON.

337. **Economic History of American Agriculture.** Same as Agricultural Economics 337 and Economics 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. Graduate students who take this course for one unit credit are required to do extra work. The student writes a scholarly paper on some approved topic in agricultural history. I; ½ or 1 unit. Prerequisite: A college level course in basic economics or American history. JONES.

339. **History of the British Commonwealth in the Nineteenth Century, 1783 to 1900.** I; ½ to 1 unit. ERICKSON.

340. **History of the British Commonwealth in the Twentieth Century, 1901 to the Present.** II; ½ to 1 unit. ERICKSON.

345. **Constitutional History of England to 1485.** I; ½ to 1 unit. LYON.

346. **Constitutional History of England from 1485 to the Present.** II; ½ to 1 unit. LYON.

352. **Colonial Beginnings of American Life and Institutions.** A study of the seventeenth and eighteenth century colonies. I; ½ to 1 unit. DUNBAR.

354. **The Era of the American Revolution, 1763 to 1789.** II; ½ to 1 unit. DUNBAR.

357. **Social and Economic History of the United States from 1775 to 1860.** The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. I; ½ to 1 unit. SHANNON.

358. **Social and Economic History of the United States Since 1860.** The growth of American economic life and institutions since 1860. II; ½ to 1 unit. SHANNON.

359. **The Civil War and Reconstruction.** Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. I; ½ to 1 unit. SHANNON.

361. **History of the United States from 1877 to 1917.** I; ½ to 1 unit. BATES.

362. **History of the United States Since 1917.** II; ½ to 1 unit. BATES.

363. **History of the West.** The westward movement from the Atlantic Coast to the Mississippi River; the West in national development. I; ½ unit. BELTING.

364. **The Trans-Mississippi West.** The history of Western expansion since the Louisiana Purchase; the West in the general history of the United States; Western economic and political problems. II; ½ to 1 unit.

365. **The History of Illinois to 1870.** Evolution of a typical midwestern commonwealth, with emphasis upon its political, economic, social, religious, and cultural development in the nineteenth century. I; ½ unit. SUTTON.

366. **The History of Illinois from 1870 to the Present.** The evolution of a modern American state, with emphasis upon its political life, economic growth, social and intellectual problems, and its contribution to the American nation. II; ½ unit. SUTTON.

368. **Origins of American Culture.** National, racial, and religious influences on American civilization; nativism; urbanization; assimilation vs. cultural pluralism. II; ½ to 1 unit.

369. **Constitutional Development of the United States to 1865.** I; ½ to 1 unit. BESTOR.

370. **Constitutional Development of the United States Since 1865.** II; ½ to 1 unit. BESTOR.

371. **American Intellectual and Cultural History to 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. I or II; ½ to 1 unit. BESTOR.

372. **American Intellectual and Cultural History Since 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. I or II; ½ to 1 unit. BESTOR.

373. **Diplomatic History of the United States to the End of the Nineteenth Century.** I; ½ to 1 unit. GRAEBNER.

374. **Diplomatic History of the United States in the Twentieth Century.** II; ½ to 1 unit. GRAEBNER.

375. **History of Latin America to 1824.** A survey of Latin-American history from the discovery of America until 1824. I; ½ to 1 unit. NOWELL.

376. **Latin America Since 1824.** A history of the Latin-American republics from their independence to the present. II; ½ to 1 unit. NOWELL.

377. **History of the A.B.C. Powers.** History of Argentina, Brazil, and Chile from their origins to the present. I; ½ unit. NOWELL.

378. **History of the Caribbean Area.** A survey of the Caribbean, Mexico, and Central America from the discovery of America to the present. II; ½ unit. NOWELL.

381. **Ancient Greek States.** History of the Greek States from the earliest times to 334 B.C. I; ½ to 1 unit. STARR.

382. **Alexander and His Successors.** II; ½ to 1 unit. STARR.

383. **History of the Roman Republic to 44 B.C.** I; ½ to 1 unit. SWAIN.

384. **The Roman Empire.** II; ½ to 1 unit. SWAIN.

391. **History of Eastern Asia to 1839.** History of eastern Asia (China, Japan, and Korea) to 1839. I; ½ unit.

392. **History of Eastern Asia Since 1839.** History of eastern Asia (China, Japan, and Korea) since 1839. II; ½ unit.

HOME ECONOMICS

The Department of Home Economics offers graduate work leading to the degrees of Master of Science or Master of Arts in Home Economics. The major work may be done in one of five curricula: child development and family relationships, family housing and household management, foods and nutrition, general home economics, or textiles and clothing. The degree of Master of Science in Home Economics Education is granted to those students who take their major work in the field of home economics education.

Students who elect home economics as the major subject for a master's degree should have complied with the undergraduate requirements of the field of concentration selected or should have had equivalent training. Students from allied fields are admitted; however, they are expected to make up courses prerequisite to those listed in the curriculum chosen for study.

All candidates for a master's degree in home economics must take a minimum of eight units or nine units if a thesis is not submitted. In either case at least four units are in home economics. Four units, at least two in home economics, must be courses numbered 400 or above.

Recommended home economics courses, suggested electives, and special requirements for each of the five curricula are as follows:

(1) *Child Development and Family Relationships.* A minimum of four units from Home Economics 301, 305, 410, 418, 419, and 499. The additional units may be selected from other home economics courses and from courses in such related fields as anthropology, education, library science, psychology, social work, sociology, and speech.

(2) *Family Housing and Household Management.* A minimum of two units from Home Economics 361, 375, 378, and 379, and Agricultural Engineering 393; three units from Home Economics 380, 410, 418, 419, 480, 487, and 493; two units from City Planning 372, Economics 313, 369, Sociology 407, 476, 477; and additional courses to total nine units selected from other home economics courses and from courses in such related fields as anthropology, architecture, economics, education, psychology, and sociology.

(3) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 422, 423, 430, 432, and 499. Additional units may be selected from a list of suggested courses in animal nutrition, bacteriology, chemistry, food technology, home economics, and physiology. Chemistry 354 or 350 and 355 are required.

(4) *General Home Economics.* A minimum of four units from prescribed

courses in three of the following curricula: (1), (2), (3), or (5). Additional units may be taken in other home economics courses and such other related fields as economics, education, psychology, or sociology.

(5) *Textiles and Clothing.* A minimum of four units from Home Economics 375, 380, 386, 388, 389, 395, 480, 487, and 499. Additional units may be taken in other home economics courses and such related fields as art, chemistry, economics, education, marketing, psychology, and sociology.

A list of suggested electives in each of the above curricula is available from the department upon request.

Graduate students who choose home economics as their minor for the degree of Doctor of Philosophy must have adequate preparation in home economics and must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in courses numbered above 400.

Candidates for the degree of Master of Science in Home Economics Education must earn eight units as follows: Two to two and one-half units of home economics chosen from Home Economics 361, 375, 378, 379, 320, 322, 323, 326, 330, 331, 380, 386, 388, 389, 395, 487, 301, 410, 418, and 419; Education 311 and 312, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; Education 453, one unit; Education 456, one unit, or Home Economics 377, one-half unit. The elective courses must be selected with the approval of the advisers, Professor Janice M. Smith, head of the Department of Home Economics, 260 Bevier Hall, and Professor Letitia Walsh, 334 Gregory Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in home economics may be obtained from the head of the department, 260 Bevier Hall.

GRADUATE TEACHING FACULTY

Professors: Janice M. Smith (Head of Department), Frances O. Van Duyne.
Associate Professors: E. Anderson, Harriet T. Barto, Mildred Bonnell, Ruth Galbraith, Margaret R. Goodyear, Pearl Z. Janssen, Helen E. McCullough, Elizabeth M. Osman, Jane Werden.
Assistant Professors: Karlyne Anspach, Beula V. McKey, Lorraine Trebilcock.

COURSES FOR GRADUATES

410. **Problems in Family Living.** Family relationships and their significance to the growth of family members. I or II; 1 unit. Prerequisite: Sociology 220.

418. **Seminar in Child Development.** Advanced problems in child development. I; 1 unit. Prerequisite: Home Economics 301.

419. **Seminar in Family Relationships.** Special problems in family living. II; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Home Economics 410.

422. **Seminar in Nutrition.** A study of recent literature in nutrition. I; ½ unit. Prerequisite: Graduate standing and undergraduate degree in home economics, with emphasis on foods and nutrition or comparable background in biochemistry, physiology, bacteriology, or other biological science. Smith.

423. **Problems in Human Nutrition.** Methods of assessing nutritional status of humans. II; ½ to 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Home Economics 324 or equivalent. Smith.

430. **Carbohydrates in Foods.** Same as Food Technology 430. A study of the physical and chemical properties of carbohydrates used in food and their

behavior under conditions encountered in food processing and storage. I; ¾ unit. Prerequisite: Chemistry 354 or 350 and 355, or consent of instructor. OSMAN.

480. **Seminar in Textiles.** Current literature related to development in the production, use, and care of textile fabrics. II; ½ to 1 unit. Prerequisite: Home Economics 380 or equivalent; consent of instructor. GALBRAITH.

482. **Seminar in Foods.** Review of current literature in foods research. II; ½ unit. Prerequisite: Undergraduate curriculum with major in foods and nutrition or undergraduate majors in chemistry, bacteriology, or physiology if certain undergraduate courses in foods and nutrition are included. VAN DUYNE.

487. **Seminar in Clothing.** Study and discussion of research in clothing from the aspects of psychological and sociological factors contributing to the effect of clothing on the development of individuals and on family and community group reactions. I; ½ to 1 unit. Prerequisite: Undergraduate curriculum with majors in textiles and clothing, home economics education, home economics extension, or general home economics. ANSPACH.

493. **Advanced Studies in Home Economics.** Work may be taken in the following subjects: (a) the child and the family, (b) family housing, (c) foods, (d) nutrition, (e) textiles and clothing. I, II; 1 unit. STAFF.

499. **Thesis Research.** Work may be taken in the following subjects: (a) the child and the family, (b) family housing, (c) foods, (d) nutrition, (e) textiles and clothing. I, II; ½ to 2 units. GALBRAITH, OSMAN, SMITH, VAN DUYNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Problems in Home Guidance of Children.** Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. I; ½ to 1 unit. Prerequisite: Home Economics 201 and 202; consent of instructor.

305. **Human Heredity.** Heredity in man and its relation to various individual and social problems. Lectures, discussions, and demonstrations. Graduate credit does not count toward a major in genetics. I; ½ unit.

320. **Diet in Disease.** II; ½ unit. Prerequisite: Home Economics 220. BARTO.

322. **Physical Growth and Nutrition.** Lectures, readings, and discussions. I; ½ unit. Prerequisite: Home Economics 220; consent of instructor. SMITH.

323. **Recent Advances in Foods and Nutrition.** New developments in foods and nutrition through readings, lectures, and discussions. S; ½ unit. Prerequisite: Chemistry 132 or 133; Physiology 103; Home Economics 131 and 220. VAN DUYNE.

324. **Problems in Nutrition.** Discussions and investigations. I or II; ½ to 1 unit. Prerequisite: Home Economics 220; Chemistry 354 or 350 and 355; senior standing. MCKEY.

326. **Demonstration Problems and Techniques.** Consideration of the techniques of demonstrations and problems involved. II; ½ unit. Prerequisite: One of the following: Home Economics 232, 262, 272, 301, 379, 380, 386; or consent of instructor. JANSSEN.

330. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. I, II; ½ unit. Prerequisite: Home Economics 131 and 232; Bacteriology 104. JANSSEN.

331. **Problems in Foods.** Individual problems in food preparation and preservation. II; ½ unit. Prerequisite: Home Economics 330. VAN DUYNE.

345. **Institution Management.** Purchase of food supplies and equipment for institutions; grades of food, judging of quality and cost in relation to season, pure food laws and government inspection; the storeroom and its management; equipment and furnishing; floor plans and routing; specifications for equipment; inventory of equipment; visits to stores and markets. I; ½ unit. Prerequisite: Credit or registration in Home Economics 240 and Economics 108; consent of instructor. BONNELL.

350. **Institution Organization and Management.** Organization and menu making for various types of institutions such as residence halls, cafeterias, and hospitals; personnel management and labor problems; records and cost accounting; professional ethics. Opportunity is given for observation and practice in various fields. Field trip required; estimated expense, $50.00. II; ½ to 1 unit. Prerequisite: Home Economics 220 and 240; consent of instructor. BONNELL.

351. **Special Problems on Group Feeding with Emphasis on the School Lunch.** Planned for teachers in secondary schools and for home advisers and others interested in community feeding problems. Lectures, discussions, and laboratory practice in quantity food management. Emphasis is on the school lunch program as an integral part of the educational system. Special problems in purchasing, floor plans, and equipment are required of graduate students. No credit is given to students who have had Home Economics 350. S; ½ unit. Prerequisite: Home Economics 220, 232, or equivalent; consent of instructor. Food handler's certificate required. BONNELL.

355. **Advanced Quantity Cookery and Catering.** Planned for students in the restaurant management curriculum and for other qualified students. Practice in menu making and aspects of management necessary for special catering functions and meal projects; special lectures and demonstrations emphasizing the artistry of preparation, serving, and merchandising of quality food; supervised practice in various food service units. Field trips and special assignments. II; ½ unit. Prerequisite: Home Economics 350; consent of instructor. BONNELL.

361. **Development and Function of Family Housing.** Same as Agricultural Engineering 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. II; ½ unit. Prerequisite: Home Economics 272 or consent of instructor. HINCHCLIFF.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment and equipment performance tests. I, II; ½ unit. Prerequisite: Home Economics 272; six advanced hours (Group III courses) in home economics; consent of instructor. SULLIVAN.

377. **Home Economics Extension.** History and development; types of county organizations; objectives; extension teaching tools; county program determination and evaluation. Field trips. II; ½ to 1 unit. Prerequisite: Consent of instructor. ANDERSON.

378. **Problems in Home Management.** Individual investigation and reports of specific problems in the field of home management. I; ½ unit. Prerequisite: Home Economics 272; consent of instructor. GOODYEAR, MCCULLOUGH.

379. **Problems in Home Management.** Individual investigation and reports of specific problems in the field of home management. II; ½ unit. Prerequisite: Home Economics 272; consent of instructor. GOODYEAR, MCCULLOUGH.

380. **Textiles.** Textiles from the economic, artistic, physical, and chemical viewpoints. I; ½ unit. Prerequisite: Home Economics 180; Chemistry 132; Economics 108; consent of instructor. GALBRAITH.

386. **Clothing Design and Construction.** Problems in creating original designs, developing a more thorough understanding of the figure through design adaptation, with emphasis on adaptability to fabric draping or flat pattern construction; investigation of sources of inspiration and relationship to significant trends in design. I, II; 1 unit. Prerequisite: Home Economics 285 and 286. ANSPACH.

388. **Problems in Textiles and Clothing.** Investigation and report of specific problems in the field of textiles and clothing. I; ½ unit. Prerequisite: Home Economics 286 or 380; consent of instructor. Each student undertakes an individual problem which in some cases may involve prerequisites in chemistry and physics. GALBRAITH, TREBILCOCK, WERDEN.

389. **Problems in Textiles and Clothing.** Investigation and report of specific problems in the field of textiles and clothing. II; ½ unit. Prerequisite: Home Economics 286 or 380; consent of instructor. Each student undertakes an individual problem which in some cases may involve prerequisites in chemistry and physics. GALBRAITH, TREBILCOCK, WERDEN.

395. **Fashion Analysis.** Factors affecting design, production, distribution, promotion, and trends in fashion development; forecasting, methods of measurement and prediction; price levels in relation to fashion cycle and quality in design and workmanship. Field trip; estimated expense, $10.00. II; ½ unit. Prerequisite: Marketing 281 or Journalism 281; senior standing; consent of instructor. TREBILCOCK.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy degrees. Candidates may specialize for either degree in floriculture, plant breeding, pomology, or vegetable crops.

The minimum grade-point average for admission to graduate study in horticulture is 3.5.

Twenty hours of undergraduate work in horticulture and allied subjects are required of students who choose horticulture as a major, and twelve hours are required of those who select it as a minor. The department waives certain of these requirements for some fields of major study if the student has had an equivalent preparation in the fundamental sciences. It is desirable, when the major field of study is decided upon during the junior or senior year, to select the fundamental science courses accordingly and, if possible, to include in the undergraduate preparation the elementary courses in German or French.

Advanced work in agricultural economics, agronomy, botany, chemistry, entomology, genetics, or plant pathology may be taken advantageously with horticulture to make a well-balanced course of graduate study.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in horticulture may be obtained from the head of the department, 125 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: C. J. BIRKELAND (Head of Department), W. A. HUELSEN, R. V. LOTT, V. G. MILUM, F. F. WEINARD.

Associate Professors: C. Y. ARNOLD, J. R. KAMP, J. P. MCCOLLUM.

Assistant Professors: W. P. BEMIS, D. F. DAYTON, R. K. SIMONS, A. E. THOMPSON, J. S. TITUS.

COURSES FOR GRADUATES

424. **Mineral Nutrition of Plants.** Same as Agronomy 424 and Botany 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. II; 1 unit. Prerequisite: Botany 130 or consent of instructor. HAGEMAN.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy 440, Animal Science 440, Dairy Science 440, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. JACOB.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy 441, Animal Science 441, Dairy Science 441, and Veterinary Medical Science 441. A continuation of Horticulture 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Horticulture 440 or equivalent. JACOB.

447. **Horticulture Seminar.** Discussion of current research and literature pertaining to problems of horticulture and related fields. I, II; ¼ unit. STAFF.

492. **Special Topics in Horticulture.** Readings and discussions in selected phases of horticulture including such topics as genetics, physiology, anatomy, morphology, and ecology of horticultural crops. I, II; ½ to 2 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. STAFF.

499. **Thesis Research.** Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. I, II; 0 to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Fruit Diseases.** Same as Plant Pathology 307. Symptomatology; laboratory and field studies of representative diseases; control measures. II; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. POWELL.

308. **Vegetable and Canning Crop Diseases.** Same as Plant Pathology 308. Symptomatology; laboratory and field studies of representative diseases; control measures. I; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. LINN.

321. **Floricultural Physiology.** Plant hormones, light, temperature, humidity, and gases on growth of ornamental plants; principles of disease and insect control. Lectures, assigned readings, discussion. I; ½ unit. Prerequisite: Botany 130. WEINARD.

322. **Plant Nutrition.** Soil conditions in relation to the growth of ornamental plants; soil and plant tissue tests, fertilizers and their use; soilless culture; water supplies and automatic watering. Lectures, assigned readings, discussions. II; ½ unit. Prerequisite: Botany 130; Agronomy 201. WEINARD.

333. **Marketing Horticultural Products.** Same as Agricultural Economics 333 and Marketing 333. Products and their utilization; institutions, functions, and agencies; merchandising methods; economic problems involved in horticultural marketing. I; ½ unit. Prerequisite: Agricultural Economics 230,

or Marketing 101, or five hours of horticulture, or consent of instructor. KELLY.

345. **Growth and Development of Vegetable Crops.** Factors affecting growth, development, and quality of vegetable crops. Discussions. I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Botany 130 or consent of instructor. MCCOLLUM.

363. **Advanced Pomology.** The development and performance of fruit plants as influenced by environment and production practices. Discussion, lectures, and laboratory. Three-day field trip; transportation furnished. I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Horticulture 262, Botany 130, and Agronomy 201, or consent of instructor. SIMONS, TITUS.

382. **Improvement of Horticultural Crops by Breeding.** Mechanism of hereditary variations and varietal differentiation in horticultural plants as a basis for determining the method of approach to crop improvement problems, with emphasis on asexually propagated crops. II; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Horticulture 110 or equivalent. THOMPSON.

HUMANITIES

The Division of the Humanities is composed of the Departments of Classics, English, French, German, History, Philosophy, Spanish and Italian, and Speech. It sponsors several courses of interdepartmental interest and purpose, serving the liberal arts and sciences requirement in general education. Its teaching faculty consists of the full-time faculties of the departments listed, of the rank of instructor and above.

COURSES FOR GRADUATES

441. **Seminar in the Structure of Literature.** Same as Communications 441. The study of present-day structural theories in literary criticism, particularly the application of recent linguistic methods. II; 1 unit. KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Linguistics.** Same as Communications 301. An introduction to the science of descriptive linguistics. I; ½ to 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

302. **Comparative Linguistics.** Same as Communications 302. An introduction to the historical aspects of language. II; ½ to 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences or equivalent. KAHANE.

JOURNALISM AND COMMUNICATIONS

Two advanced degrees are offered: the Master of Science degree with a major in news-editorial, advertising, or radio and television; and the Master of Television degree.

For the program leading to the Doctor of Philosophy degree in Communications, see page 91.

Degree of Master of Science in Journalism. Admission to this program is based on the following: (1) completion of the requirements for a bachelor's

degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in journalism, English, or the social sciences; (2) a grade-point average of at least 3.75.

Requirements for this degree include:

(1) A major in editorial, advertising, or radio-television consisting of four units, or three units in journalism and communications and one additional unit approved by the Graduate College, including:

(a) For editorial majors, at least two units from Journalism 471, 473, and 474. Editorial candidates who do not present an acceptable undergraduate major in journalism are required to complete Journalism 311, 321, and 323.

(b) For advertising majors, at least two units from Journalism 471, 481, and 482. Advertising candidates who do not present an acceptable undergraduate major in journalism are required to complete Journalism 382, 383, and 384.

(c) For radio-television majors, at least one unit from Journalism 462 or 471. Radio-television candidates who do not present an acceptable undergraduate major in journalism are required to complete Journalism 252, Television Laboratory, 368, and 386.

(2) A minor of at least two units in a subject other than journalism.

(a) For editorial majors, the recommended fields are economics, English, history, philosophy, political science, psychology, and sociology.

(b) For advertising students, the recommended fields are economics, home economics, marketing, psychology, and sociology.

(c) For radio-television students, the recommended fields are economics, political science, psychology, sociology, and speech.

(3) A thesis, which may be for one or two units.

(4) A minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

Degree of Master of Television. This program provides professional training for persons who expect to go into non-engineering areas of television.

For admission, a candidate must have a bachelor's degree from an accredited institution, must meet the minimum requirements for admission to the Graduate College, and ordinarily must have majored in radio, television, theater arts, journalism, or some other area related to television. Applicants for admission are selected by an entrance committee. Candidates who do not present acceptable undergraduate training are required to complete the following undergraduate courses: Journalism 252, Television Laboratory, and Journalism 261, Principles of Radio and Television Broadcasting. Under exceptional circumstances, such as professional experience in television broadcasting, this requirement may be waived.

Requirements for the degree of Master of Television include a total of eight units of credit, with a minimum of six units selected from courses in the television sequence. The following courses must be included among the six units of television: (1) Journalism 462, one unit; (2) Journalism 450, two units; (3) Journalism 368, one-half unit, and Journalism 386, one-half unit, if these courses or their equivalents have not been completed on the undergraduate level.

Students are expected to plan their programs around a special interest area. These areas of special interest include television production and direction, television writing, television news, television advertising, cinematography for television, television art, and television scenic design.

This program differs from the regular Master of Science program in these respects: it does not require a thesis, but instead requires study in special problems of television; it does not require a minor but permits concentration in the fifth year in the radio and television field.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in journalism may be obtained from the dean of the college, 119 Gregory Hall.

In addition to University fellowships, the International Circulation Managers' Association awards annually two fellowships of $750 each to graduates in journalism who intend to continue their education. Information concerning these fellowships may be obtained from H. Phelps Gates, *Christian Science Monitor,* Boston, head of the association committee which makes the awards.

GRADUATE TEACHING FACULTY

Professors: T. B. Peterson (Dean of the College of Journalism and Communications), R. R. Barlow, L. W. McClure, L. W. Murphy, C. E. Osgood, C. H. Sandage, D. W. Smythe.

Associate Professors: D. E. Brown, H. V. Cordier, F. E. Schooley.

Assistant Professors: G. Gerbner, J. W. Jensen, H. S. Maclay, J. J. Mullen, J. H. Schacht, A. E. Strang, J. C. Sutton, P. H. Tannenbaum.

Instructors: M. D. Froke, G. G. Hanson, R. L. Rider, H. W. Sargent.

Lecturer: H. J. Skornia.

COURSES FOR GRADUATES

450. **Special Problems in Television.** Project work for advanced students in specific areas of television including news, advertising, directing, writing, etc. I, II; 1 to 2 units. Students may reregister for this course up to a total of four units. Prerequisite: A television course in the area of specialization; consent of instructor. Rider.

451. **Television Program Management and Production.** Problems in originating, planning, and producing television programs. II; 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor. Cordier.

462. **Seminar in Radio and Television.** Same as Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. I; 1 unit. Skornia.

467. **The Political Economy of Communications, I.** Same as Communications 467. Analysis of theory and problems concerning such social agencies of communication as newspapers, magazines, books, postal service, and telegraph, with special emphasis on their policies and structures. I; 1 unit. Prerequisite: Economics 102 and 103, or 108, or consent of instructor. Smythe.

468. **The Political Economy of Communications, II.** Same as Communications 468. Analysis of theory and problems concerning such social agencies of communication as telephone, radio services (including television), and motion pictures, with special emphasis on their policies and structures. II; 1 unit. Prerequisite: Journalism 467. Smythe.

471. **Proseminar in Communications, I.** Same as Communications 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. I; 1 unit. Smythe and others.

472. **Proseminar in Communications, II.** Same as Communications 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. II; 1 unit. Osgood and others.

473. **History and Theory of Freedom of the Press.** Same as Communications 473.

Development of the Anglo-American press system; philosophical bases of competing press systems. I; 1 unit. JENSEN.

474. **Government and Mass Communications.** Same as Communications 474. Current legal, constitutional, and administrative problems of media of mass communications; contemporary issues resulting from the restrictive, regulatory, and supplementary activities of government in the field of mass communications. II; 1 unit. JENSEN.

481. **Advanced Advertising Principles.** Same as Communications 481 and Marketing 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Communications 482 and Marketing 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both non-quantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

490. **Research in Special Topics.** Same as Communications 490. I, II; ½ to 1 unit. Students may reregister for a total of 2 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** I, II; 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **High School Journalism.** Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. II; ½ unit. Prerequisite: Education 211 or consent of instructor. BROWN, HANSON.

309. **Public Relations.** Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. I; ½ unit. MURPHY.

310. **Press Systems of the World.** Press of England, France, Germany, Italy, Russia, Latin America, China, and Japan; international organization of the press. II; ½ unit. BARLOW.

311. **Newspaper Law.** Freedom of the press; the right to gather, publish, and comment on the news. I, II; ½ unit.

320. **Editorial Studies and Writing.** Writing of editorials and preparation of editorial judgments. Policies for editorials and for the editorial page. I; ½ unit. Prerequisite: Journalism 212. BARLOW.

321. **Copyreading.** Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and makeup and design of newspaper pages. I, II; 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212. SUTTON.

323. **Advanced Reporting.** Advanced types of news investigation and treatment. I, II; ½ unit. Prerequisite: Journalism 211 and 212 or equivalent. BARLOW.

326. **Magazine Article Writing.** Preparation of feature stories and articles; techniques of marketing, market analysis, and selling of articles written in the course. I, II; ½ unit. SCHACHT.

327. **Special Topics in Twentieth Century Journalism.** Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. II; ½ unit. Prerequisite: One course in college history; consent of instructor. MURPHY.

328. **Industrial Publications.** Problems and techniques of editing house organs. I; ½ unit. Prerequisite: Journalism 211 or 326. SARGENT.

329. Critical Writing and Reviewing. News and comment of the stage, books, movies, and fine arts. II; ½ unit. Prerequisite: Journalism 212 or consent of instructor. MURPHY.

341. Newspaper Management. Principles and methods in the operation of daily and weekly newspapers; managerial problems of the editorial, advertising, circulation, and commercial printing departments; plant operation. I; ½ unit. Prerequisite: Credit or registration in Journalism 204. MCCLURE.

344. Community Newspaper Publication. Study of weekly newspapers in handling news, editorials, features, pictures, and correspondence; and in meeting business, circulation, and advertising problems. Includes one or more field trips for each student, with actual work on a small newspaper. II; ½ unit. Prerequisite: Journalism 211. STRANG.

351. Graphic Production Processes. Detailed study of the preparation of copy and illustrative material for the mass production of news, features, and advertising; comparison of quality and costs of production processes; consideration of personnel, equipment, and raw materials entering into graphic production. II; ½ unit. Prerequisite: Journalism 204. HANSON.

353. Television Script Writing. General principles of writing for television, including all non-dramatic and dramatic forms. II; ½ unit. Prerequisite: Journalism 252; consent of instructor. CORDIER.

354. Television Directing. The theory and techniques of directing the television program. Experience in directing laboratory productions. I, II; ½ unit. Prerequisite: Journalism 252; consent of instructor. RIDER.

355. Television News. News coverage, script preparation, use of visual materials and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. I, II; ½ unit. Prerequisite: Consent of instructor. FROKE.

356. Cinematography for Television. The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. I, II; ½ unit. Prerequisite: Consent of instructor. RIDER.

357. Television Staging and Lighting. The theory and practice of staging and lighting for television. II; ½ unit. Prerequisite: Journalism 252.

362. Radio and Television Station Management. A study of the organization and administration of the radio staff and station; public relations, personnel management, and station operation; analysis of station and agency relationships and radio sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. I; ½ unit. Prerequisite: Journalism 261. SCHOOLEY.

365. Radio News. News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. I, II; ½ unit. Prerequisite: Journalism 211. BROWN.

366. Advanced Radio and Television Practices, I. Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. I; ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. Advanced Radio and Television Practices, II. Continuation of Journalism 366. II; ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. Radio and Television Regulation. Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and

editorial selections, copyright, and author-producer relations. II; ½ unit. SCHOOLEY.

372. **Social Aspects of Mass Communications.** Same as Communications 372. Basic principles of social communication by film, radio, television, popular music, and literature; the media as institutions and as the "public arts" of modern society; products, practices, and standards of popular culture in American life. I, II; ½ unit. GERBNER.

382. **Advertising Copy and Layout.** Same as Marketing 382. Theory and practice of advertising copy writing and layout for newspaper, magazine, and direct mail; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. I, II; 1 unit. Prerequisite: Journalism 204 and 281. SARGENT.

383. **Advertising Media.** Same as Marketing 383. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. I, II; ½ unit. Prerequisite: Journalism 281. MULLEN.

384. **Advertising Campaigns.** Same as Marketing 384. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements — copy and layout. Graduate students do not receive credit for both Journalism 384 and 387. I, II; ½ unit. Prerequisite: Journalism 282 or 382, and 383. MULLEN.

385. **Advertising Promotion and Sales.** Same as Marketing 385. Sales problems, advertising promotion, advertising research, market research. I, II; ½ unit. Prerequisite: Journalism 281. MCCLURE.

386. **Radio and Television Advertising.** Same as Marketing 386. Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. I, II; ½ unit. Prerequisite: Journalism 281. SANDAGE.

387. **Advertising Policies and Problems.** Same as Marketing 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Consideration is given to management problems at both the national and retail levels. Graduate students do not receive credit for both Journalism 384 and 387. I, II; ½ to 1 unit. Prerequisite: Journalism 281. WEDDING.

392. **Research Methods for Press, Radio, and Television.** Same as Communications 392. An introduction to relevant research methods and practices for mass media personnel who need to use research as a tool of management and policy, order research, and interpret research. Lectures, readings, and laboratory practice. II; ½ unit. TANNENBAUM.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a degree of Master of Arts in Labor and Industrial Relations through an integrated curriculum of the social sciences which apply to this field. Students taking advanced degrees in other departments may arrange a minor in industrial relations.

Students applying for admission must have a grade-point average of at least 3.5.

The institute's study program is based on the student's need for an understanding of the broad social and economic factors shaping our industrial society,

some degree of specialization, and opportunities for practical experience in the field.

Students are admitted to the institute on approval of the director and upon presenting a minimum of twenty-one hours in the social sciences, of which six should be in economics other than statistics. Other social sciences include history, philosophy, political science, psychology, and sociology. At least three hours credit in statistics and three hours credit in labor economics or labor problems are to be included in the total of twenty-one hours.

Students who can not meet these special course prerequisites may register for graduate work but must remove any deficiency during the first year of residence by taking the prescribed courses without graduate credit, unless exempted for reasons satisfactory to the adviser in charge.

A candidate for the Master of Arts degree in Labor and Industrial Relations must complete eight units of graduate credit including one unit in the research seminar in labor and industrial relations (Labor and Industrial Relations 493), five units to be selected from appropriate courses, and two units devoted to the writing of a thesis.

With the approval of the institute, courses to meet the five-unit requirement may also be selected from those offered in other departments of the University.

In addition to the eight units described above, the student must have a work experience for a minimum of three months. The student must show through oral and written examinations that he has an understanding of the practical problems involved in employer-employee relationships. It is also important that he understand the effects of various solutions of these problems on the employer, the employee, the industry, and the community outside the plant.

Although previous work experience may be offered by means of a detailed petition, it is advisable for the student to have one semester of graduate study before his work experience in order to prepare himself more adequately for his oral and written examinations. Work experience examinations must be completed at least one month in advance of the thesis examination.

Full details of the institute program are given in the bulletin "Graduate Study in Labor and Industrial Relations" which may be obtained by writing to the Institute of Labor and Industrial Relations, 704 South Sixth Street, Champaign.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in labor and industrial relations may be obtained from the institute, 704 South Sixth Street, Champaign.

GRADUATE TEACHING FACULTY

Professors: R. W. Fleming (Director of the Institute of Labor and Industrial Relations), W. E. Chalmers, M. Derber, P. L. Garman, W. H. McPherson.

Associate Professors: Margaret K. Chandler, M. Edelman, S. B. Levine, H. Rosen, R. C. Wilcock.

Assistant Professor: B. Karsh.

COURSES FOR GRADUATES

401. Crucial Issues in Industrial Relations. Identification of the most crucial problems facing labor, management, and the public in pursuit of common, conflicting, and interrelated objectives in industrial relations. Based on an integrated approach combining the concepts of economics, psychology, sociology, and political science as applicable to these problems. I, II; 1 unit. Prerequisite: Registration in the Institute of Labor and Industrial Relations curriculum or consent of instructor. Chalmers, Levine.

418. **Seminar in Industrial Sociology.** Same as Sociology 418. Individual research in sociological interpretation of industrial organization; the orientation and motivation of the individual in industry and commerce; labor-management relations as group adjustments; the interrelations of industry and the community. I or II; 1 unit. Prerequisite: Six hours of sociology including Sociology 318, or consent of instructor. CHANDLER, KARSH.

420. **Formation of Public Policy.** Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. I or II; 1 unit. HAGAN.

423. **Politics of Labor Law.** Same as Political Science 423. Labor's role in politics and as a pressure group; theories of labor policy formation; organization, procedures, and policy development in the administration of labor law; labor policy formation in the courts; labor's role in foreign political systems. I, II; 1 unit. Prerequisite: Consent of instructor. EDELMAN.

435. **Motivation and Morale in Industry.** Same as Psychology 435. Concepts and methods in the study of motivation of employees; determinants of employees attitudes and job satisfaction; modification of attitudes and morale. I or II; 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. ROSEN.

440. **Labor Economics.** Same as Economics 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. I; 1 unit. Prerequisite: Six hours of economics. MCNATT.

441. **Labor Economics.** Same as Economics 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. II; 1 unit. Prerequisite: Six hours of economics. MCNATT.

442. **Problems and Practices in Collective Bargaining.** Same as Economics 442. Seminar in the methods and techniques of collective bargaining in the negotiation of the labor contract; nature and significance of labor agreements; union, management, and public interests in major contract provisions. I, II; 1 unit. Prerequisite: Consent of instructor. CHALMERS.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Economics 443. Seminar in the techniques of labor contract administration; comparative study of grievance procedure operation; analysis of conciliation, fact-finding, and arbitration procedures, including case studies of arbitration awards. I, II; 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

444. **The Labor Market.** Same as Economics 444. Basic labor force concepts and measurement; economic theory of market operation and contemporary research; long and short run changes in labor force size, composition, mobility, and participation rates; wartime problems of mobilizing labor resources; international aspects, industrial and military, of differential population and labor force growth; public policy and market operation. I; 1 unit. Prerequisite: Six hours of economics. PARRISH.

445. **The Labor Market.** Same as Economics 445. Concepts, sources of materials, methods of analysis, nature of labor supply; nature of labor demand and recruitment; determinants of interplant occupational mobility with emphasis on the wage structure and the role of wages in allocation of labor supply; ad-

justment to technological change; problems of the older worker; development of market policy by unions and management; development of public policy including employment service and anti-discrimination programs. II; 1 unit. Prerequisite: Six hours of economics. PARRISH.

447. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure and government of the modern American trade union movement with particular reference to the relation between organization and function. Problems relating to the function and execution of economic policies, the maintenance of unity and discipline, the adjustment of jurisdictional conflicts, and the observance of agreements are examined and appraised. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. GARMAN.

448. **Problems of Personnel Management.** Same as Management 448. An examination of the organization and administration of the personnel function in management. Deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. I; 1 unit. Prerequisite: Economics 248 or equivalent; consent of instructor. PLANTY.

449. **Problems of Personnel Management.** Same as Management 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. II; 1 unit. Prerequisite: Economics 248, Labor and Industrial Relations 448, or equivalent. PLANTY.

450. **Case Problems in Industrial Relations.** A seminar in the analysis of case problems drawn from industry, unions, and government. The cases involve actual and specific situations facing the various participants concerned with or affected by administrative decision-making. Case analysis is based upon principles of administrative behavior. Proposed solutions are developed through both group and individual analysis, and both oral discussion and written presentation of analyses and recommendations are used. I, II; 1 unit. Prerequisite: Labor and Industrial Relations 493 and two other graduate courses in labor and industrial relations; consent of instructor. LEVINE, WILCOCK.

493. **Research Seminar in Labor and Industrial Relations.** Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, LEVINE.

494. **Labor Relations in Modern Society.** An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. I or II; 1 unit. Prerequisite: Consent of instructor. DERBER.

496. **The Evolution of Labor-Management Relations in America.** Analysis and interpretation of the development of labor-management relations at the plant and industry levels from the stages of master and servant and master and journeyman in colonial times to the stage of constitutional government and industrial democracy in the present day. I, II; 1 unit. Prerequisite: Consent of instructor. DERBER.

499. **Thesis Research.** For all students writing theses in labor and industrial relations. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

312. **Human Relations in Business.** Same as Management 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. I, II; ½ unit. Prerequisite: Management 101 or equivalent. DAUTEN, PLANTY.

318. **Human Relations in Industry.** Same as Sociology 318. Sociology of industry and problems of personal adjustment; the emergence of modern industrial and labor organizations and their impact upon community life. I, II; ½ to 1 unit. Registration for a full graduate unit requires both the approval of the instructor and substantial additional work. Prerequisite: Psychology 100; Sociology 100 or 104 and 105, or Division of General Studies 151 and 152, or consent of instructor. CHANDLER, KARSH.

342. **Economics of Social Security.** Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MCNATT.

344. **The Law and Labor.** Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; Economics 240. MCNATT.

346. **Foreign Labor Movements.** Same as Economics 346. Analysis of the history, organization, economic policies, political programs, and domestic, international, and contemporary influence of the labor movements of Great Britain, Sweden, Germany, France, Latin America, and Russia. I; ½ to 1 unit. Prerequisite: Economics 240. CHALMERS.

347. **Labor Law.** Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; collective bargaining and labor contracts; wages and hours legislation; unemployment compensation. I or II; 1 unit. FLEMING.

357. **Psychology of Industrial Conflict.** Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. Motives, emotions, attitudes, and ways of perceiving situations are considered in relation to the actions of industrial executives, factory workers, and union leaders. Results of factory observation, public opinion polls, laboratory experimentation, and psychoanalysis are integrated to provide a systematic interpretation of the problem, and to evaluate proposed actions toward a solution. I, II; ½ to 1 unit. Prerequisite: Psychology 100 or equivalent; Psychology 245, Economics 240, or Sociology 318. ROSEN.

360. **Group Insurance and Pensions.** Same as Finance 360. A study of the problems faced by management and labor in establishing employee benefit plans for death, disability, and retirement. Actual case problems are used in the course. I; ½ to 1 unit. Prerequisite: Finance 240 or 260, or Management 248. MEHR.

365. **Government and Labor.** Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. I or II; ½ to 1 unit. EDELMAN.

368. **Public Personnel Administration.** Same as Political Science 368. An analysis of personnel management in government. Recruitment and selection, job and salary classification, work standards, training, and the role of labor and professional organizations in the public services are considered in the light of current theory and practice. I or II; ½ to 1 unit. PAGE.

LAW

The College of Law offers a program of graduate work leading to the degree of Master of Laws (LL.M.) and to the degree of Doctor of the Science of Law (J.S.D.).

For admission, an applicant must have received a first degree in law from the University of Illinois or from a law school approved by the University, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws degree unless he has a grade average of 3.5 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of the Science of Law is normally required to have a grade average of 4.0 in all law work previously undertaken, and also to present evidence that he has the capacity to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Bachelor of Laws degree or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for either degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the LL.M. must secure an average of 3.5 in his graduate law courses; the candidate for the J.S.D., an average of 4.0.

Details of the programs may be obtained from the dean of the College of Law, 209 Law Building.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in law may be obtained from the dean of the college, 209 Law Building.

GRADUATE TEACHING FACULTY

Professors: R. N. SULLIVAN (Dean of College of Law), C. H. BOWMAN, K. S. CARLSTON, E. W. CLEARY, R. G. COHN, J. E. CRIBBET, H. W. HOLT, W. D. WARREN, J. N. YOUNG.

LIBRARY SCIENCE

The purpose of the Library School is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree and the doctor's degree in library science.

Following suitable undergraduate preparation in general educational subjects as well as professional library courses, a fifth year of advanced professional

study, combined with some advanced non-library studies, leads to the degree of Master of Science in Library Science. This degree represents the minimum academic preparation for professional librarianship.

Experienced librarians of marked professional capacity and promise may pursue a program of advanced study and research leading to the degree of Doctor of Philosophy in Library Science. The normal minimum period of study is two years beyond the master's degree.

Students holding bachelor's degrees from any accredited institution but without previous course work in library science are eligible for admission to the master's program upon completion of the pregraduate professional core. Normally, this may be accomplished in any regular summer session.

Students holding bachelor's degrees from any accredited four-year or five-year library school may be admitted directly to the master's program without further course work.

Degree of Master of Science. Applicants for admission to the Library School must first be admitted to the Graduate College. Ordinarily applications are not considered from persons over thirty-five years of age unless they have been actively employed within recent years in library work or in teaching.

In addition to the Graduate College requirements, applicants to the Library School must meet the following requirements:

(1) A reading knowledge of at least one modern foreign language. This requirement may be met either by completing at least one academic year of study at the college level or by passing a proficiency examination administered by the Library School.

(2) Preprofessional study appropriate for advanced study in library science.

(3) Completion of a prescribed program of undergraduate library science courses. This requirement may be met by one of the following:

(a) Completion of at least eighteen semester hours of library science with a grade average of at least 3.75 from an institution approved by the University of Illinois Library School.

(b) Completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, from the University of Illinois Library School with a grade average of at least 3.75. Exemption from one or more of these courses may be secured by a satisfactory score on proficiency examinations which are offered on the day preceding the opening of registration each semester and summer session.

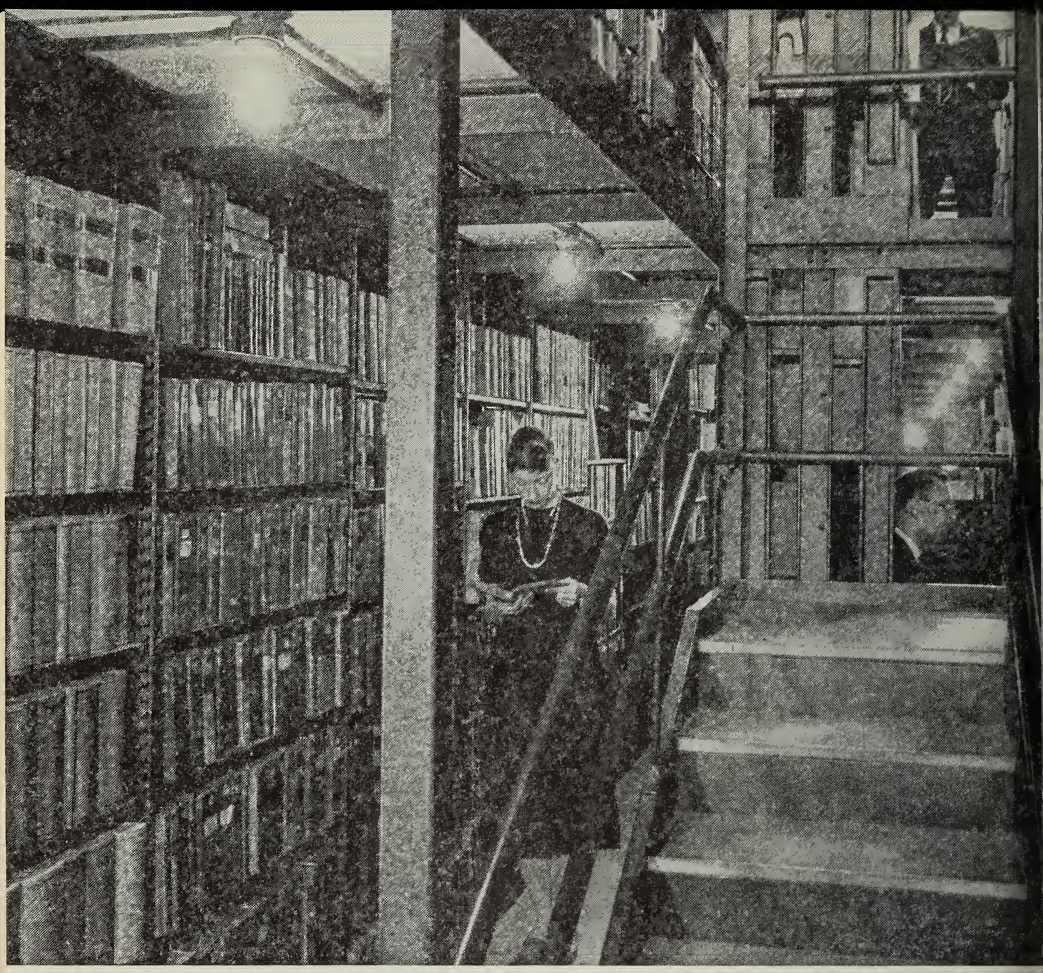
There is a special offering of these four courses each eight-week summer session, enabling beginning students to complete the entire preparatory sequence prior to entry into the regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program, and students are urged to plan accordingly.

(4) Evidence of ability to pursue graduate work in library science.

Each student's program of study is planned to suit his particular needs and purposes. This is done in consultation with an adviser at the time of original registration and thereafter. Students who have completed their undergraduate library science requirement in institutions other than the University of Illinois are required to complete Library Science 405, 407, 409, and 411 or 412. The general field work program is required of students lacking equivalent library experience.

Depending upon his previous training, a student may do a portion of his study outside the Library School. Students thinking of careers in special libraries may find useful the varied courses available through cooperation with other departments of the University.

No thesis is required, but to insure that every candidate for a master's degree has satisfactorily demonstrated his ability to assemble, organize, and present information and ideas in acceptable written form, each student is required to



Books are a primary instrument of research, particularly in the humanities and the social sciences. The University of Illinois has a distinguished library available for its students and staff.

prepare a formal term paper in one of his library science courses, this paper to be designated as the master's project.

At least two semesters in residence, or the equivalent, are required to attain the master's degree, apart from the preparatory courses. In this period, eight units of graduate study are to be completed. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five.

Advanced Master's Program. Students possessing a fifth-year bachelor's degree from an accredited library school are enrolled in the advanced master's program. A thesis is optional, and may, under certain circumstances and with specific approval of the Graduate College, be written *in absentia.* The course of study for an advanced student is, with the assistance of the student's adviser, individually planned. There are no specified or required library science courses and as many as four of the eight required units may be earned in courses offered in other departments of the University.

Correspondence regarding admission should be addressed to the Associate Director of the Library School, from whom the detailed Library School announcement and the necessary application blanks can be secured. All applications, transcripts, and other necessary papers should be filed as early as possible and not later than four weeks before the date of registration. No student should complete his plans for attending the Library School until he has been notified of his admission.

Degree of Doctor of Philosophy. A student desiring to pursue a program of study and research leading to the degree of Doctor of Philosophy in Library Science must meet the customary admission requirements of the Graduate College. In addition, he must meet the following requirements of the Library School:

(1) A master's degree in library science from an accredited library school or a bachelor's degree in library science from an accredited library school plus a master's degree in a subject field.

(2) A substantial period of acceptable professional library experience.

(3) Evidence of capacity for research and productive scholarship.

The normal minimum period of study required for the degree of Doctor of Philosophy is two years beyond the master's degree, during which the student is required to devote all his working time to studies. All three years must be spent in resident graduate study at some accredited educational institution, and either the first two or the last two must be spent at the University of Illinois. The degree is conferred, however, not for residence during a certain period but for scholarly attainments and power of investigation as proved by a thesis and examinations.

Candidates for this degree must meet the general requirements of the Graduate College regarding residence, language requirements, academic program, and thesis.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in library science may be obtained from the Associate Director of the Library School, 331 Library.

In addition to University fellowships, the following fellowships are available to graduate students in library science:

The Katharine L. Sharp Fellowship was endowed in 1933 by the Library School Association as a memorial to the founder of the Library School. This fellowship is awarded biennially on recommendation of the faculty. It carries a stipend of $600.00 and exemption from tuition.

The Lois Wells Irwin Fellowship was established in 1955 as a memorial to Lois Wells Irwin, for thirty-two years an active member of the Board of Directors of the Quincy, Illinois, Public Library. Awarded annually upon recommendation of the faculty, the fellowship carries a grant of $500.00 and exemption from tuition.

GRADUATE TEACHING FACULTY

Professors: R. B. Downs (Director of Library School), Thelma Eaton, Frances B. Jenkins, A. H. Lancour, Rose B. Phelps, C. W. Stone.

Associate Professors: L. E. Bamber, D. E. Strout.

Assistant Professors: Marie M. Hostetter, W. V. Jackson, M. Alice Lohrer, B. M. Woods.

COURSES FOR GRADUATES

402. **Studies in Reading.** Designed to acquaint students with the major areas of investigation and library interest in reading. Special attention is given to studies of reading interests and habits. Class discussions are devoted to analysis of various studies and their implications for librarians. II; 1 unit. Hostetter.

403. **Methods of Investigation.** Survey of library literature, with attention to examples of research in the library field, to elementary statistical procedures, and to the methods of investigation applicable to librarianship. Designed to prepare consumers rather than producers of research results. I; 1 unit. Jenkins.

405. **Library Administration.** Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. I; 1 unit. Lancour.

406. **Library Service to Children and Young People.** The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young people in the public library. II; 1 unit. Lohrer.

407. **Cataloging and Classification, I.** The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and the Library of Congress subject headings. I; 1 unit. Eaton.

408. **Cataloging and Classification, II.** The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloging department. II; 1 unit. Prerequisite: Library Science 407. Eaton.

409. **Communication Roles and Responsibilities of Libraries.** Reviews briefly theories of learning and the communication process. Considers basic communication activities, problems, and research pertaining to normal library practices; the fostering of community relationships; maintaining intellectual freedom; effective use of mass media; and application of photographic and electronic aids. I; 1 unit. Stone.

410. **Adult Education.** Reviews the literature, history, and present scope of adult education in the United States; introduces various patterns of community organization for adult education and identifies significant educational programs conducted by libraries. Students become familiar with adult education methods, techniques, and materials used in many types of adult education programs. II; 1 unit. Stone.

411. **Bibliography of the Humanities and Social Sciences.** Detailed consideration of the bibliographical and reference materials in some ten subject fields,

with training and practice in their use for solving questions arising in reference service. I; 1 unit. PHELPS.

412. **Bibliography of Science and Technology.** Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. II; 1 unit. Prerequisite: Library Science 302 or consent of instructor. JENKINS.

424. **Government Publications.** The nature and scope of American and British government publications; the problems of organization arising from their form and from the methods of their production and distribution. II; 1 unit. PHELPS.

427. **Resources of American Libraries.** Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; types of library materials; and ways and means of developing research collections in special subject fields. I; 1 unit. JACKSON.

428. **Physical Problems of Libraries.** Consideration of principles and problems affecting the construction, remodeling, and equipment of the main types of libraries, with emphasis on their interelationships, administrative implications, and recent developments. II; 1 unit. STROUT.

430. **Advanced Bibliography.** Designed to enable the student to utilize the varied resources of a large research library. Deals with the method of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. II; 1 unit. Prerequisite: Library Science 424 or consent of instructor. PHELPS.

431. **History of Libraries.** The development of libraries from those of Nineveh to the present day. Includes the Hellenic libraries, Roman libraries, monastery libraries of the Middle Ages; the work of the great book collectors in building up collections which were turned over to national libraries; the development of the great private, academic, and tax supported libraries which survive today. I; ½ to 1 unit. EATON.

432. **History of Books and Printing.** The origin and evolution of the alphabet and of scripts; the history of manuscript books; the invention and spread of printing; the account of the production and distribution of printed books. Emphasis is placed on the relation of books to social conditions in the various periods studied. II; 1 unit. EATON.

433. **Biological Literature and Reference Work.** Introduction to use of the indexes and abstract journals serving the biological sciences and related fields. The handling of pertinent general library aids, the preparation of scientific manuscripts, and the history of scientific societies also are considered. I, II; ¼ unit. BAMBER.

434. **Larger Units of Library Organization.** A study of cooperation, contracts, county and regional arrangements, and other devices for the provision of school and public library service by units covering more than a local area. Emphasis is on legal and administrative aspects, and not on operational procedures. II; 1 unit. STROUT.

436. **Development of the Library Catalog.** The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. II; 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor. EATON.

439. **Medical Literature and Reference Work.** Considers representative refer-

ence and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources. II; 1 unit. Prerequisite: Consent of instructor. JENKINS.

441. **History of Children's Literature.** Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. I; 1 unit. LOHRER.

COURSES FOR ADVANCED GRADUATES

450. **Advanced Studies in Librarianship.** Directed and supervised detailed investigation of selected problems. Work may be taken in the following fields for a maximum of two units in each: reference service; cataloging and classification; reading; college and university libraries; public libraries; school libraries; special libraries; subject bibliography, etc. I, II; 1 to 4 units. STAFF.

461. **Descriptive Bibliography.** An introduction to descriptive bibliography, its methods, ideals, and purposes from the time of Bradshaw and Proctor to Greg and Bowers. Not a course in descriptive cataloging. S; 1 unit. Prerequisite: Open to advanced students from the Library School and other departments of the University with consent of instructor. EATON.

462. **Education for Librarianship.** A study of the development of library education in this country and abroad. Not a course in teaching methods, but designed to provide understanding of the philosophical foundations of the several training agencies through analysis of their methods, content, character of personnel, and relationship to the profession at various times. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. LANGOUR.

463. **Current Developments in Technical Services.** An examination of changing policies and procedures in the administration of cataloging, classification, and related areas. I; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. EATON.

464. **College and University Library Problems.** Investigation and review of administrative and educational problems in college and university libraries. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STROUT.

465. **Librarianship and Society.** Emphasis in this course is on the place of libraries as instruments of social thought and action in the twentieth century, as compared with the place and purpose of the library in the societies of the past. I; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STROUT.

469. **Principles of Research Methods.** Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. I; 1 unit. Prerequisite: Knowledge of the principles of statistics; Master of Science in Library Science or consent of instructor. STONE.

499. **Thesis Research.** Individual study and research. I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Literature of the Humanities and Social Sciences.** This course is designed to build a knowledge of the scope and significant characteristics of the several

fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. I; 1 unit. STROUT.

302. **Literature of Science and Technology.** An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. II; 1 unit. JENKINS.

303. **Library Materials for Children.** The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard book selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. I, II; ½ to 1 unit. HOSTETTER, LOHRER.

304. **Library Materials for Adolescents.** The selection and use of library materials for adolescents in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. I, II; ½ to 1 unit. HOSTETTER, LOHRER.

306. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the acquisition, care, and library use of maps. Classes become familiar with the major cartobibliographical and related aids. II; ½ to 1 unit. WOODS.

308. **Audio-Visual Services in Libraries.** The development of audio-visual work in libraries. Students become aware of the range, types, and functions of the audio-visual materials, equipment, and services commonly provided, and of some organizational and technical problems met by specialists in the field. Laboratory sessions afford practical experience in working with many types of materials and equipment including radio and television. II; ½ unit (or 1 unit for candidates for the Master of Science in Library Science, upon approval of the instructor). STONE.

309. **Storytelling.** Fundamental principles of the art of storytelling including techniques of adaptation and presentation for children of various ages. Content and sources of materials; story cycles; methods of learning; practice in storytelling; planning the story hour for the school and public libraries, for recreational centers, for the radio, and television. Open to undergraduates and non-Library School students. I; ½ unit. LOHRER.

MANAGEMENT

The Department of Management offers graduate work either as a major or a minor leading to the degree of Master of Science, and as a minor for the Doctor of Philosophy degree.

For admission a student must have a grade-point average of 3.5 or above.

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration subjects such as accountancy, business law, economics, management, and marketing, at least six hours of which must have been in the field of management.

To do minor work in this field, a student must have had at least twelve hours of work in the subjects named above, of which three must have been in management.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in management may be obtained from the head of the department, 216 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professors: M. J. Mandeville (Head of Department), L. A. Bryan, P. M. Dauten, P. M. Green, E. G. Planty.
Assistant Professor: I. L. Heckmann.

COURSES FOR GRADUATES

401. **Scientific Management.** A study of the development of modern industrial management and the principles and practices employed at the present time. I; 1 unit. Dauten.

402. **Scientific Management.** A study of the development of modern industrial management and the principles and practices employed at the present time. II; 1 unit. Dauten.

403. **Evolution and Development of Industry.** The evolution of industry from ancient times to the present; the social, economic, and political developments consequent upon the change from manufacturing for personal use to the present-day mass production industries. Consideration is given to the transition in organization for manufacture, technological changes, capital requirements, human relations, production processes, the location of industries, governmental control, and management responsibilities. I, II; 1 unit.

416. **Problems in Business Policy.** Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. I, II; 1 unit. Mandeville.

448. **Problems of Personnel Management.** Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. Deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. I; 1 unit. Prerequisite: Management 248 or equivalent; consent of instructor. Planty.

449. **Problems of Personnel Management.** Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. II; 1 unit. Prerequisite: Management 248, 448, or equivalent. Planty.

499. **Thesis Research.** I, II; 1 unit. Green, Mandeville, Planty.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Management in Manufacturing.** Internal problems of production and efficient control in factories. I, II; ½ unit. Prerequisite: Management 101.

311. **Administrative Policies and Organization.** Development of administrative organizations and the determination of policies for the integration of major activities of a business enterprise. I, II; ½ unit. Prerequisite: Management 101; Marketing 101. MANDEVILLE.

312. **Human Relations in Business.** Same as Labor and Industrial Relations 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. I, II; ½ unit. Prerequisite: Management 101 or equivalent. DAUTEN, PLANTY.

362. **Job, Wage, and Contract Administration.** An advanced, specialized treatment of the techniques, methods, and problems current in the wage and salary field. I, II; ½ unit. Prerequisite: Any one of the following courses or their equivalent: Psychology 145, 290, Economics 240, Management 248. HECKMANN.

MARKETING

Work may be done in the field of marketing for a major or a minor for the Master of Science degree and for a minor for the Doctor of Philosophy degree. To do major work in this field, a student must have a grade-point average of at least 3.5 and must have completed at least twenty hours of undergraduate work in marketing, management, economics, business law, or accountancy, at least six hours of which must have been in the field of marketing. To do minor work in this field a student must have had at least twelve hours of work in the subjects named above, of which three must have been in marketing.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in marketing may be obtained from the head of the department, 411 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professors: H. W. HUEGY (Head of Department), F. H. BEACH, F. M. JONES, H. G. WALES, N. WEDDING.
Associate Professors: R. D. MILLICAN, R. V. MITCHELL, D. W. SCOTTON.
Assistant Professors: L. M. DEBOER, R. M. HILL.

COURSES FOR GRADUATES

401. **Marketing Principles and Problems.** Functional, commodity, and institutional methods of studying marketing with particular reference to the analysis and classifications of functions, commodities, and institutions. I, II; 1 unit. HUEGY.

402. **Marketing Methods and Problems.** Selected problems in the operation and management of market institutions. I, II; 1 unit. JONES.

407. **Prices and Price Policies.** An examination of the role of prices in our economy, and of price making under conditions of competition, monopoly, or monopolistic competition, with special emphasis on non-price competition; an examination of business pricing policies and of their acquisitive and social implications and significance. I, II; 1 unit. HUEGY.

415. **Merchandising Trends and Problems.** The literature, trends, policies, and organization problems involved in retail merchandising. I; 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor. JONES.

416. **Merchandising Policies and Problems.** The policies and problems relating to

merchandise control, personnel, publicity, and promotion; recent literature and legislation. II; 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor. JONES.

421. **Analysis of Consumer Markets.** A study of consumers and their demands. I, II; 1 unit. MILLICAN.

422. **Advanced Marketing Research.** Advanced marketing research theory, literature, objectives, techniques, and problems of marketing research. II; 1 unit. Prerequisite: Marketing 321 or consent of instructor. WALES.

471. **History of Marketing.** The development of marketing organizations, problems, and methods in the United States from colonial times to the present. Wholesaling, retailing, market growth, consumer buying habits, advertising, selling, pricing, legislation, trade channels. II; 1 unit. Prerequisite: Marketing 101 or consent of instructor. JONES.

472. **Sales Campaigns.** Problems in managing the sales force. I, II; 1 unit. BEACH.

481. **Advanced Advertising Principles.** Same as Journalism 481 and Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Journalism 482 and Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communication. Both non-quantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

493. **Research in Special Fields.** I, II; ¼ to 2 units.

499. **Thesis Research.** Thesis or independent study in the field of marketing. I, II; 0 to 2 units. HUEGY, JONES, and others.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Contemporary Problems in Marketing Management.** The problems which marketing managers are currently facing and an analysis of the policy decisions they must make to operate effectively. I, II; ½ unit. Prerequisite: Marketing 101. MITCHELL.

315. **Retail Buying.** Principles and procedures in buying for resale. Organization for buying, analysis of customer demand, model stock plans, sources of supply, resident buying, cooperative and central buying, foreign buying, selection of merchandise, and trade relations. I, II; ½ unit. Prerequisite: Marketing 211. HILL.

321. **Marketing Research and Policies.** The basic techniques used in business research and specific research projects, and how their findings are used in the formulation of marketing policies. I, II; ½ unit. Prerequisite: Marketing 101. DEBOER.

323. **Problems in Business Research.** Selected problems in the field of commercial research. I, II; ½ to 1 unit. Prerequisite: Marketing 321. DEBOER.

325. **Sales and Distribution Cost Analysis.** Basic techniques and principles of sales and distribution cost analysis for management control of marketing activities. I, II; ½ unit. Prerequisite: Marketing 101.

331. **Grain Marketing.** Same as Agricultural Economics 331. Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially futures markets; inventory management; operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00.

I; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or consent of instructor. HIERONYMUS.

332. **Livestock Marketing.** Same as Agricultural Economics 332 and Animal Science 332. Problems and practices in marketing livestock. Field trip; estimated expense, $7.00. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. BROADBENT.

333. **Marketing Horticultural Products.** Same as Agricultural Economics 333 and Horticulture 333. Products and their utilization; institutions, functions, and agencies; merchandising methods; economic problems involved in horticultural marketing. I; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or five hours of horticulture, or consent of instructor. KELLY.

334. **Marketing Dairy Products.** Same as Agricultural Economics 334 and Dairy Science 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5.00. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

345. **Credits and Collections.** Retail and mercantile credit and collection principles and practices. I, II; ½ unit. Prerequisite: Marketing 101 or Agricultural Economics 230. COLE, SCOTTON.

349. **Trade Association and Commercial Organization.** Principles of trade association and chamber of commerce organization and management. II; ½ unit. PARSONS.

351. **Industrial Marketing.** The special problems involved in marketing materials, equipment, and supplies to manufacturers, other business firms, and institutions who use the goods in further production; determination of methods and policies appropriate to the goods and the marketing situations. I or II; ½ unit. Prerequisite: Marketing 101 or 272, or consent of instructor. HILL.

372. **Advanced Salesmanship.** An application of sales techniques to actual selling situations. Students make sales presentations, and critical appraisals are given. I, II; ¼ unit. Prerequisite: Marketing 271. TONNING, WALES.

373. **Sales Management.** Modern sales organization; selling problems of manufacturers, wholesalers, and retailers; management of salesmen. I, II; ½ to 1 unit. Prerequisite: Marketing 271. BEACH.

382. **Advertising Copy and Layout.** Same as Journalism 382. Theory and practice of advertising copy writing and layout for newspaper, magazine, and direct mail; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. I, II; 1 unit. Prerequisite: Journalism 204; Marketing 281. SARGENT.

383. **Advertising Media.** Same as Journalism 383. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. I, II; ½ unit. Prerequisite: Marketing 281. MULLEN.

384. **Advertising Campaigns.** Same as Journalism 384. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements — copy and layout. Graduate students do not receive credit for both Marketing 384 and 387. I, II; ½ unit. Prerequisite: Marketing 282 or 382; and 383. WEDDING.

385. **Advertising Promotion and Sales.** Same as Journalism 385. Sales problems,

advertising promotion, advertising research, market research. I, II; ½ unit. Prerequisite: Marketing 281. McClure.

386. **Radio and Television Advertising.** Same as Journalism 386. Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. I, II; ½ unit. Prerequisite: Marketing 281. Sandage.

387. **Advertising Policies and Problems.** Same as Journalism 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Consideration is given to management problems at both the national and retail levels. Graduate students do not receive credit for both Marketing 384 and 387. I, II; ½ to 1 unit. Prerequisite: Marketing 281. Wedding.

Note: See also Business Administration 373, Electronic Data Processing for Business.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the degrees of Master of Arts or Master of Science and Doctor of Philosophy in Mathematics and in Statistics. Research for the doctor's degree in mathematics can be carried out in the fields of algebra, analysis, applied mathematics, geometry, and topology.

For information concerning applied mathematics, see page 196.

MATHEMATICS

For admission to full standing, a beginning graduate student must have a grade-point average of not less than 3.5.

In order to begin graduate work without deficiencies with a major in mathematics, a student should have had twenty hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and one year of more advanced work in one or more of the fields of algebra, analysis, and geometry.

Candidates for a Doctor of Philosophy degree taking a sole minor in mathematics are expected to complete four units approved by the department. Those taking a first or second minor are required to complete at least two units beyond calculus.

The more technical courses offered by the department are arranged mainly in cycles of two or of three years, so that a properly qualified student usually has opportunity to take any particular course at some time during the three years of residence required for the doctor's degree.

Candidates for the degree of Master of Science in the Teaching of Mathematics must earn four units in mathematics (two units of which are electives), two units in education, and two units in electives. Requirements are Mathematics 317 or 327, one unit; Mathematics 318 or 328, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in mathematics and the other electives must be selected with the approval of the adviser. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have the same grade-point average as that required by the department. The adviser for candidates for this degree is Professor H. R. Brahana, 369 Altgeld Hall.

Candidates for the degree of Master of Science in the Teaching of Mathematics and the Physical Sciences must earn two units in mathematics, one unit in chemistry, one unit in physics, two units in education, and two units in electives. Requirements are Mathematics 347 or 343, one unit; Mathematics 348 or 345, one unit; Chemistry 340, one unit; Physics 322, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives may be in mathematics, in education, in chemistry, or in physics. Students applying for admission must have a grade-point average of at least 3.5. The adviser for candidates for this degree is Professor H. R. Brahana, 369 Altgeld Hall.

STATISTICS

This program of study is developed for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology.

For admission to full standing a beginning graduate student must have a grade-point average of not less than 3.5. The completion of a thorough course in calculus is also a prerequisite to admission. A course in advanced calculus, while not required, is found helpful. Students are admitted on limited status.

This program is administered by the Department of Mathematics with the help of a small interdepartmental advisory committee. The thesis for the degree of Doctor of Philosophy must show capacity for important original contributions to one or more of the following: development of new statistical ideas and methods; improvement of applications of statistical methods; and new uses of statistical methods in some field of application. The work of individual students is supervised by one adviser if the courses referred to as electives in the following are taken in general statistics; otherwise by two advisers, one representing the field of general statistics and one mathematics or a field of application.

A candidate for the degree of Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College (note the requirement of a minor of at least two units in an area of study other than statistics or mathematics), must complete the following courses: (1) Mathematics 315, 347, or equivalents; (2) eight units of statistics of which at least four must be courses at the 400 level, selected from a list of courses prepared by the Mathematics Department and including all courses in statistics listed jointly by the Mathematics Department and areas of application; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

A candidate for the degree of Master of Arts in Statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be 400 courses, selected from a list as in (2) above; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 20-23) he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

The courses required under (4) above are determined by the interests of the student. They may be taken in general statistics, in mathematics, or in an area of application. Thus, the graduate degrees in statistics permit considerable variation in the division of emphasis between general statistics and the area of application.

A graduate student in statistics has two advisers, one for statistical theory, one for the area of application.

Candidates for a Doctor of Philosophy degree taking a sole minor in statistics are expected to have completed a course in calculus and are required to complete four units of work in statistics having calculus as prerequisite. Those taking a first or second minor in statistics are required to complete at least two units of work in statistics having calculus as prerequisite.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in mathematics may be obtained from the head of the department, 273 Altgeld Hall.

GRADUATE TEACHING FACULTY

Professors: M. M. Day (Head of Department), D. G. Bourgin, H. R. Brahana, S. S. Cairns, J. L. Doob, G. P. Hochschild, P. W. Ketchum, H. Levy, C. W. Mendel, H. J. Miles, A. H. Taub, W. J. Trjitzinsky.

Associate Professors: P. T. Bateman, C. R. Blyth, W. A. Ferguson, A. Heller, F. E. Hohn, J. Landin, G. E. Moore, D. E. Muller, M. E. Munroe, J. W. Peters, W. J. Poppelbaum, I. Reiner, E. J. Scott, L. L. Steimley, H. E. Vaughan.

Assistant Professors: Beulah M. Armstrong, R. G. Bartle, O. K. Bower, D. L. Burkholder, Josephine H. Chanler, D. B. Gillies, N. T. Hamilton, Corrine R. Hattan, V. A. Hoersch, R. G. Langebartel, H. A. Osborn, Echo D. Pepper, Jewell E. Schubert, M. Suzuki, W. M. Zaring.

COURSES FOR GRADUATES

401. **Theory of Fields.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

402. **Linear Algebra.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

403. **Theory of Rings.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

404. **Group Theory.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

407. **Representation Theory and Classical Groups.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

408. **Lie Groups.** I, II; 1 unit. Prerequisite: Mathematics 332, 404, and 441.

415. **Advanced Topics in the Theory of Groups.** I, II; 1 unit. Prerequisite: Consent of instructor.

416. **Advanced Topics in Abstract Algebra.** I, II; 1 unit. Prerequisite: Consent of instructor.

420. **Projective Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328.

422. **Algebraic Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328.

423. **Differential Geometry.** I, II; 1 unit. Prerequisite: Mathematics 343.

424. **Riemannian Geometry.** I, II; 1 unit. Prerequisite: Mathematics 420, or 423, or consent of instructor.

426. **Differential Geometry in the Large.** I, II; 1 unit. Prerequisite: Mathematics 332 or 423, or consent of instructor.

427. **Foundations of Geometry.** I, II; 1 unit. Prerequisite: Consent of instructor.

428. **Topics in Geometry.** I, II; 1 unit. Prerequisite: Consent of instructor.

430. **Elementary Geometry from a Modern Viewpoint.** Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern approach. I, II; 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

431. **Number, Length, Area.** Deals with the development of the integers, rational numbers, real numbers, variables, functions, limits, area, length, volume. The principal emphasis is upon the mathematical needs of the secondary school teacher. I, II; 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

434. **Combinatorial Theory of Complexes.** I, II; 1 unit. Prerequisite: Mathematics 333.

438. **Topics in Topology.** I, II; 1 unit. Prerequisite: Consent of instructor.

439. **Seminar in Topology.** I, II; 1 unit. Prerequisite: Consent of instructor.

440. **Theory of Functions of a Complex Variable, I.** I, II; 1 unit. Prerequisite: Mathematics 348 or consent of instructor.

441. **Functions of Real Variables.** I, II; 1 unit. Prerequisite: Mathematics 347.

442. **Measure and Integration.** I, II; 1 unit. Prerequisite: Mathematics 347; consent of instructor.

444. **Partial Differential Equations.** I, II; 1 unit. Prerequisite: Consent of instructor.

445. **Theory of Functions of a Complex Variable.** I, II; 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. **Hilbert Space.** I, II; 1 unit. Prerequisite: Mathematics 442.

447. **Banach Spaces.** I, II; 1 unit. Prerequisite: Mathematics 442.

449. **Normed Rings.** I, II; 1 unit. Prerequisite: Mathematics 318 and 446 or 447.

450. **Semi-Ordered Spaces.** I, II; 1 unit. Prerequisite: Mathematics 446 or 447.

451. **Theory of Probability.** I, II; 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** I, II; 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 317 and 348.

454. **Analytic Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods of Physics.** I, II; 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods of Physics.** I, II; 1 unit. Prerequisite: Mathematics 455.

457. **High-Speed Computing.** I, II; 1 unit. Prerequisite: Consent of instructor.

459. **Topics in Hydrodynamics.** I, II; 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy 424 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. McVittie.

464. **Dynamics of the Earth's Atmosphere.** Same as Astronomy 464 and Physics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

468. **Topics in Analysis.** I, II; 1 unit. Prerequisite: Consent of instructor.

469. **Seminar in Analysis.** I, II; 1 unit. Prerequisite: Consent of instructor.

470. **Statistical Decision Functions.** Statistics from the point of view of decision making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to non-sequential and sequential decision making in practice. I, II; 1 unit. Prerequisite: Consent of instructor.

472. **Econometrics.** Same as Economics 472. Application of the principles of mathematical statistics to estimation of economic relationships. II; 1 unit. Prerequisite: Mathematics 363; consent of instructor.

473. **The Theory of Testing Hypotheses.** Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. I, II; 1 unit. Prerequisite: Consent of instructor.

474. **The Theory of Estimation.** Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. I, II; 1 unit. Prerequisite: Consent of instructor.

478. **Topics in Statistics.** I, II; 1 unit. Prerequisite: Consent of instructor.

490. **Reading Course.** I, II; 1 to 2 units. Prerequisite: Consent of instructor.

493. **Proseminar.** An introduction to the methods and tools of mathematical research. The work of the course consists in the solution by the students of assigned problems in various fields of mathematics and the presentation of these solutions in both written and oral form. I, II; 1 unit. Prerequisite: Mathematics 347; credit or registration in Mathematics 348.

499. **Thesis Research.** I, II; 0 to 4 units. Prerequisite: Consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Fundamental Concepts of Mathematics.** I; 1 unit. Prerequisite: One year of calculus or consent of instructor.

302. **Fundamental Concepts of Mathematics.** II; 1 unit. Prerequisite: One year of calculus or consent of instructor.

305. **Teachers' Course.** A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry. Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic. Topics suitable for presentation for superior high school students are also considered. I, II; ½ to 1 unit. Prerequisite: One year of calculus or consent of instructor.

306. **Selected Mathematical Topics in Secondary Schools, I.** This course deals with the teaching of the following topics in secondary school mathematics: symbolism and numbers; directed numbers; variables; equations (linear, quadratic, systems); sets; graphs; bases of enumeration; functions; critical examination of these topics. I, II; ½ to 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

307. **Selected Mathematical Topics in Secondary Schools, II.** This course deals with the teaching of the following topics in high school mathematics: variables in geometry; logical analysis of geometrical propositions; equivalence relations in geometry including congruence and similarity; geometry in the coordinate plane; cosine and sine as real valued functions of real arguments; a comparison of these functions with those ordinarily taught in the high school; symmetry; periodicity; evenness and oddness; exponential and logarithmic functions. I, II; ½ to 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

311. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. I; 1 unit. Prerequisite: One year of calculus or consent of instructor.

312. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. II; 1 unit. Prerequisite: One year of calculus or consent of instructor.

315. **Linear Transformations and Matrices.** I, II; 1 unit. Prerequisite: One year of calculus.

317. **Introduction to Higher Algebra.** I; 1 unit. Prerequisite: One year of calculus.

318. **Introduction to Higher Algebra.** II; 1 unit. Prerequisite: Mathematics 317.

327. **Introduction to Higher Geometry.** I; 1 unit. Prerequisite: One year of calculus.

328. **Introduction to Higher Geometry.** II; 1 unit. Prerequisite: Mathematics 327.

332. **Topological Spaces.** I, II; 1 unit. Prerequisite: Credit or registration in Mathematics 347.

333. **Combinatorial Topology.** I, II; 1 unit. Prerequisite: Mathematics 343.

341. **Differential Equations.** I, II; 1 unit. Prerequisite: One year of calculus.

342. **Differential Equations.** I, II; 1 unit. Prerequisite: Mathematics 341.

343. **Advanced Calculus.** I, II; 1 unit. Prerequisite: One year of calculus.

345. **Differential Equations and Orthogonal Functions.** I, II; 1 unit. Prerequisite: One year of calculus.

346. **Complex Variables and Applications.** For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take Mathematics 348. Credit is not given for both Mathematics 346 and 348. I, II; 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. **Introduction to Higher Analysis: Real Variables.** I, II; 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. **Introduction to Higher Analysis: Complex Variables.** I, II; 1 unit. Prerequisite: Mathematics 347.

353. **Elementary Theory of Numbers.** I; 1 unit: Prerequisite: Credit or registration in Mathematics 317 or 347.

354. **Elementary Theory of Numbers.** II; 1 unit. Prerequisite: Mathematics 317 or 353.

358. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. I, II; ½ unit. Prerequisite: Mathematics 111 or 112.

359. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. I, II; ½ unit. Prerequisite: Mathematics 358.

361. **Theory of Probability.** II; 1 unit. Prerequisite: One year of calculus.

362. **Finite Differences.** I; 1 unit. Prerequisite: One year of calculus.

363. **Advanced Statistics.** I, II; 1 unit. Prerequisite: One year of calculus.

364. **Advanced Statistics.** I, II; 1 unit. Prerequisite: Mathematics 363.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Agronomy 365. A study of computing methods for efficient utilization of high speed equipment in the processing of statistical data. Emphasis is on prin-

ciples of application of computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accomplished. I; ¾ unit. Prerequisite: A 300-level course in statistics or statistical methods, or consent of instructor. JACOB.

375. **Nonparametric Inference.** Nonparametric tests of hypotheses concerning means, variances, regression, and correlation coefficients; methods depending on ranks; the efficiency of nonparametric tests. I, II; 1 unit. Prerequisite: Mathematics 361 or 363.

381. **Vector and Tensor Analysis.** I; 1 unit. Prerequisite: Mathematics 343, or equivalent, or consent of instructor.

382. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** II; 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

384. **Logical Design of Automatic Digital Computer Circuits.** Same as Electrical Engineering 384. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. I, II; 1 unit. Prerequisite: Senior standing; consent of instructor.

385. **Digital Computer Programming.** I, II; 1 unit. Prerequisite: Senior standing; consent of instructor.

386. **Laplace Transforms.** I, II; 1 unit. Prerequisite: Mathematics 343.

387. **Introduction to Numerical Methods.** I or II; 1 unit. Prerequisite: Mathematics 343.

388. **Mathematical Methods in Enginering and Science.** I or II; 1 unit. Prerequisite: Mathematics 343.

391. **Boolean Algebras with Applications to Computer Circuits, I.** Same as Electrical Engineering 391. An introduction to Boolean algebra with a discussion of the elementary applications to set theory, logic, and both relay and electronic switching circuits. The Harvard chart method and other methods for circuit simplification are treated both as applied to single output and multiple output circuits. I, II; ½ to 1 unit. Prerequisite: Senior standing; consent of instructor.

392. **Boolean Algebras with Applications to Computer Circuits, II.** Same as Electrical Engineering 392. The notion of time as a parameter is introduced into the theoretical treatment of switching circuits. Examples of synthesis of time-dependent circuits are given using mathematical techniques. I, II; ½ to 1 unit. Prerequisite: Mathematics 391.

MATHEMATICS (APPLIED)

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, are offered by various departments in the College of Engineering and the College of Liberal Arts and Sciences. Graduate students working in applied mathematics and interested in one or more of these particular fields register in one department of the University and work for the Master of Science or the Doctor of Philosophy degree in that department.

The Committee on Applied Mathematics advises graduate students interested in one of the branches of applied mathematics listed above. Students can call on the Committee for help in planning a basic course of study which will serve as preparation for subsequent specialization and research work in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical

meteorology, or the mathematical problems related to digital computer use and design. The graduate degree toward which the student is working is supervised by the department of the student's specialization.

Detailed information concerning the programs of study and research in various branches of applied mathematics may be obtained by writing to the Chairman of the Committee on Applied Mathematics, Professor A. H. Taub, Digital Computer Laboratory.

MECHANICAL ENGINEERING

(Including Industrial Engineering and Nuclear Engineering)

The Department of Mechanical Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. Advanced study and professional training are offered in the general fields of power, design, and production.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements for the degree of Bachelor of Science in mechanical engineering at the University of Illinois, with a grade-point average of at least 3.5. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

Except under unusual circumstances the maximum number of credits which is permitted in any course whose number ends in 8 or 9 is three units toward the requirements for a master's degree. An additional four units of credit are permitted for candidates working toward a doctor's degree. In most cases the research work conducted in these laboratory investigations can be reported in the thesis submitted for fulfillment of the requirements for each degree. A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is required if a thesis is not included.

For further information see the booklet "Graduate Study and Research in Mechanical Engineering." Copies may be obtained from the Department of Mechanical Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the chairman of the graduate committee, Department of Mechanical Engineering.

For information concerning applied mathematics, see page 196.

For information concerning the requirements for the degree of Master of Science in Nuclear Engineering, see page 201.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in mechanical engineering may be obtained from the head of the department, 144 Mechanical Engineering Building.

GRADUATE TEACHING FACULTY

Professors: N. A. Parker (Head of Department), E. L. Broghamer, B. T. Chao, L. E. Doyle, W. N. Espy, J. R. Fellows, G. W. Harper, W. S. Harris, E. F. Hebrank, J. A. Henry, W. L. Hull, S. Konzo, H. H. Korst, R. F. Larson, R. J. Martin, L. C. Pigage, D. G. Ryan, H. J. Schrader (Cooperating), F. Seyfarth, K. J. Trigger.

Associate Professors: H. D. Bareither, J. R. Carroll, J. L. Leach, T. W. Price, E. I. Radzimovsky.

Assistant Professors: W. E. Bair, W. L. Chow, W. F. Stoecker.

Mechanical Engineering

COURSES FOR GRADUATES

401. **Thermodynamics.** Application of thermodynamics to the analysis and solution of engineering problems involving energy transfer and conversion. I; 1 unit. Prerequisite: One year course in thermodynamics. Espy.

402. **Thermodynamics of Gaseous Equilibrium.** Application of thermodynamics to analysis of combustion of gases used as working media in power production. II; 1 unit. Prerequisite: One year course in thermodynamics. Espy.

403. **Advanced Combustion.** A study of the theories of combustion. Solid, liquid, and gaseous fuels as used in engineering structures. Emphasis is on experimental methods in combustion. I, II; 1 unit. Prerequisite: Undergraduate courses in thermodynamics and differential equations. Bair, Price.

404. **Gas Dynamics.** Introduction to theoretical gas dynamics; properties of compressible real fluids, fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multi-dimensional problems. I; 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. Korst.

405. **Heat Transfer.** Analysis of the methods and mechanisms of heat transfer: dimensional analysis method, design of heat exchangers, transient state heat transfer. Special problems in insulation and heat transfer. II; 1 unit. Prerequisite: Undergraduate course in heat transfer. Chao, Larson.

406. **Heat Conduction in Solids.** Fundamentals; general differential equation of heat conduction; methods of solution; steady state heat flow; transient heat flow, one and two dimensions; periodic flow of heat; internal heat source in solids. I; 1 unit. Prerequisite: Undergraduate course in differential equations. Chao.

407. **Selected Topics in Gas Dynamics.** Theoretical analyses of non-steady processes including scavenging, pulse jet, shock tube, and comprex compressor. Includes an introduction to high velocity laboratory techniques. II; 1 unit. Prerequisite: Mechanical Engineering 404. Korst.

408. **Laboratory Investigations in Thermodynamics.** Special investigations involving thermodynamic analysis, thermodynamic properties, and performance of physical and chemical systems. I, II; ½ to 1½ units. Prerequisite: One year course in thermodynamics; one half-year course in power laboratory. Bair, Chow, Espy, Korst.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigations in flow, metering, heat transfer, heat exchanger performance and design. I, II; ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. Bair, Chao, Chow, Korst, Larson, Price.

421. **Heating and Air Conditioning.** Advanced study of heating, ventilating, and air conditioning. Factors affecting heat loss and heat gain of building, physiological effects of environment, equipment design of heat transfer equipment. Individual problems. I; 1 unit. Prerequisite: Undergraduate course in heating, ventilating, and air conditioning. Bareither, Carroll, Fellows, Konzo.

423. **Refrigeration Theory and Application.** Advanced study of processes and cycles; design problems; and special applications. II; 1 unit. Prerequisite: Undergraduate course in refrigeration. Martin, Stoecker.

428. **Laboratory Investigations in Refrigeration.** Special investigations in refrigeration. I, II; ½ to 1½ units. Martin, Stoecker.

429. **Laboratory Investigation in Heating and Air Conditioning.** Special investigations in heating, ventilating, and air conditioning. I, II; ½ to 1½ units. Pre-

requisite: Two semesters of power laboratory, or equivalent. BAREITHER, CARROLL, FELLOWS, HARRIS, KONZO.

432. **Theory of Rotary Compressors.** Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbo-compressors; regulation; rotary positive blowers. II; 1 unit. Prerequisite: Mechanical Engineering 205 and 206; Theoretical and Applied Mechanics 232 or Aeronautical Engineering 211 and 212. KORST.

438. **Laboratory Investigations in Power Machinery.** Special investigations in power machinery, such as turbines, engines, fans, and compressors. I, II; ½ to 1½ units. Prerequisite: One year course in power laboratory. BAREITHER, HEBRANK, HULL.

441. **Machine Design.** A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper consideration of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. RYAN.

443. **Dynamics of Machinery.** Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, critical speeds, and vibrations in shafts; gyroscopic action in machines; flywheels, governors, and special topics. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER, RYAN.

445. **Design of Internal Combustion Engines.** Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determination of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. I; 1 unit. Prerequisite: Undergraduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

448. **Laboratory Investigations in Machine Design.** Special investigations in machine design. I, II; ½ to 1½ units. BROGHAMER, RADZIMOVSKY, RYAN.

451. **Metal Cutting.** A study of the theoretical factors involved in metal cutting and forming. Basic mechanics of machining processes; friction and surface finish; temperatures developed during machining operations and the effect upon chip formation. Analysis of experimental data. Lecture and discussion periods. Survey of current literature and special topic assignments. I; 1 unit. Prerequisite: Undergraduate courses in advanced metal processing and heat treatment of metals or physical metallurgy. TRIGGER.

458. **Laboratory Investigations in Production.** Special investigations in the field of production, particularly in materials processing, metal cutting, and production engineering. I, II; ½ to 1½ units. HARPER, LEACH, PIGAGE, TRIGGER.

468. **Laboratory Investigations in Railway Mechanical Engineering.** Special investigations in the field of railway mechanical engineering. I, II; ½ to 1½ units. Prerequisite: Bachelor of Science degree in mechanical engineering. SCHRADER.

493. **Seminar.** Presentation and discussion of significant developments in mechanical engineering. I, II; no credit. KONZO.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Nuclear Power Engineering.** Principles of release and exploitation of nuclear energy; uranium fission and the controlled chain reaction, reactor types and design principles; radiation hazards and shielding, adaptations and economics. II; ½ to ¾ unit. LARSON.

303. **Fuels and Combustion.** Fuel resources; composition and specification of natural and manufactured fuels; combustion stoichiometry; fuel calorimeters; coal, oil, and gas burners; fire box and chimney design; smoke abatement. I; ½ to ¾ unit. Prerequisite: Chemistry 101 and 104 and Mechanical Engineering 263, or equivalent. FELLOWS.

305. **Thermodynamics of High-Velocity Flow.** The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines. I, II; ½ to ¾ unit. Prerequisite: Mechanical Engineering 206 or consent of instructor. CHOW.

311. **Instrumentation and Measurements.** Instruments and measuring equipment for flow, temperature, pressure, speed, and gas analysis. I, II; ½ to ¾ unit. KONZO.

314. **Lubrication.** The theories of lubrication; manufacture and properties of lubricants; methods of testing; lubrication methods and appliances. A study of the lubrication requirements of machines of many kinds. I; ½ to ¾ unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. RADZIMOVSKY.

322. **Heating, Ventilating, and Air Conditioning Design.** Theory and design of heating, ventilating, and air conditioning systems. I, II; ½ to ¾ unit. Prerequisite: Mechanical Engineering 252 or 260. BAREITHER, CARROLL, KONZO.

332. **Theory of Internal Combustion Engines.** Study of reciprocating engine cycles, including thermodynamics and combustion, considering such factors as fuel-air mixture, variable specific heats, chemical equilibrium and dissociation and heat losses; supercharging; flow through valves and manifolds; mixture distribution; bearings and lubrication; and effects of variables on performance. II; ½ to ¾ unit. Prerequisite: Undergraduate course in internal combustion engines. HULL.

347. **Analytical Study of the Principles of High-Speed Engines.** Study of the dynamics of high-speed internal-combustion engines, engine balance, crankshaft deflections, torsional vibrations. II; ½ or ¾ unit. Prerequisite: Mechanical Engineering 221 or 222; senior standing or consent of instructor. GREFFE.

363. **Railway Motive Power.** A technical study of the types of motive power used on railways and the conditions under which they operate. Special emphasis is on Diesel, gas turbine and steam locomotives; consideration is also given to special types, operating conditions, economics, train resistance, tractive force, speed time and distance curves. Problem in stopping trains, preparation of time tables, servicing new and old equipment and terminal and general repair facilities. II; ½ to ¾ unit. SCHRADER.

Industrial Engineering

COURSES FOR GRADUATES

453. **Methods and Measurements of Industrial Work.** Advanced theoretical analysis of factors affecting determination of economical methods, method standards, and time standards for industrial operations. Special investigations

and term paper. I; 1 unit. Prerequisite: Undergraduate course in motion and time study, and production control. PIGAGE.

454. **Production Engineering.** Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. II; 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

333. **Engineering Applications of Statistics.** Applications of statistics to engineering problems; the calculated risk in making decisions on observed data; treatment of means, percentage, and variability; control charts, acceptance sampling, linear regressions, correlation, elementary experimental design. Use of desk calculators. II; ½ to ¾ unit. Prerequisite: Mathematics 263 or 363. HENRY.

350. **Tool Engineering Analysis.** Solution of advanced problems by analytical methods with special attention to problems of dimensional planning, economics, design of tools, metal forming, and shearing tools. II; ½ to ¾ unit. Prerequisite: Industrial Engineering 282 or equivalent. DOYLE.

357. **Safety Engineering.** The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. I, II; ½ to ¾ unit. HARPER.

358. **Problems in Safety Engineering.** Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles and applications for the student interested in entering the field of safety engineering in industry. II; ½ to ¾ unit. Prerequisite: Industrial Engineering 235 or 357; consent of instructor. HARPER.

359. **Industrial Fire Protection.** Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. II; ½ to ¾ unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. HARPER.

Nuclear Engineering

The interdepartmental committee on nuclear engineering offers graduate work leading to the degree of Master of Science in Nuclear Engineering. Depending upon the area of interest, the candidate may concentrate on one or more of the following areas of work: nuclear power, nuclear metallurgy, reactor instrumentation and control, reactor design and construction.

The prerequisites for graduate work in nuclear engineering are the equivalent of the undergraduate course requirements for the degree of Bachelor of Science in the various curricula of engineering at the University of Illinois and satisfactory completion of the following courses or their approved equivalents: Mathematics 343 and 345, Physics 383 and 382, Chemistry 245 or 342. Concentration in certain areas, such as nuclear power, nuclear metallurgy, etc., may require additional background work acceptable to the adviser for this field. For example, concentration in nuclear power requires an understanding of thermodynamics and

heat transfer. Graduates of curricula in physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in nuclear engineering.

An applicant's undergraduate grade-point average must be at least 3.75.

Completion of the following program is required for the degree of Master of Science in Nuclear Engineering:

(1) Required courses (minimum of four units): Nuclear Engineering 397, 398, 454, 455, and 458.

(2) Elective courses: Nuclear Engineering 499 and graduate courses (300 and 400 level) which are pertinent to nuclear engineering and are approved by the candidate's program adviser.

A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a thesis may be waived, but a minimum of nine units is required if a thesis is not included.

For further information, see the booklet "Nuclear Engineering at the University of Illinois" available from the College of Engineering, 106 Civil Engineering Hall, or correspond with the chairman of the committee on nuclear engineering, College of Engineering.

GRADUATE TEACHING FACULTY

Professors: R. J. Martin (Chairman of Nuclear Engineering Committee), F. Adler, B. T. Chao, T. J. Dolan, G. H. Fett, A. O. Hanson, R. F. Larson, W. E. Miller, N. M. Newmark, N. A. Parker, T. A. Read, F. Seitz, G. M. Sinclair, M. Wayman.

Associate Professors: R. W. Bohl, R. S. Engelbrecht, E. D. Lynch, J. W. Westwater.

Instructor: J. P. Hummel.

COURSES FOR GRADUATES

454. **Nuclear Engineering Laboratory Investigations.** Special investigations in nuclear engineering including aspects of metallurgy, heat transfer, instrumentation, measurement and control. I. II; ½ to 1½ units. Prerequisite: Physics 382; consent of instructor.

455. **Nuclear Reactor Theory.** An introduction to the basic physics involved in the understanding and design of nuclear reactors; the mathematical description of the steady state neutron distribution and reactor kinetics. I; 1 unit. Prerequisite: Physics 382 or consent of instructor.

458. **Nuclear Reactor Engineering.** Development of engineering design phases of the fission chain reactor; reactor materials and radiations, thermal aspects, heat removal, radiation hazards, shielding, reactor performance, controls and instrumentation, types and applications, fuel conversion, reactor power economics. II; 1 unit.

499. **Thesis Research.** I, II; 0 to 1 unit.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

397. **Radiochemistry.** Same as Chemistry 397. Properties of radioactive nuclei, nature of radioactivity, nuclear reactions, detection equipment, and tracer technique. I, II; ½ unit. Prerequisite: One semester of physical chemistry or consent of instructor.

398. **Radiochemistry Laboratory.** Same as Chemistry 398. Laboratory to accompany Nuclear Engineering 397. I, II; ¼ unit. Prerequisite: Credit or registration in Nuclear Engineering 397, or consent of instructor.

MINING AND METALLURGICAL ENGINEERING

The Department of Mining and Metallurgical Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. The prerequisite for graduate work with metallurgical engineering or mining engineering as a major is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in the major field of study at the University of Illinois. A student who is deficient in background and previous training may be required to register in certain undergraduate courses (without graduate credit) as a prerequisite to graduate work. At the end of the student's first registration his adviser enters on a "Memorandum of Prerequisites" the undergraduate courses necessary for the student to complete.

A candidate for the degree of Master of Science is ordinarily required to have a minimum of eight units of graduate work, including a thesis. However, a degree is not granted for this minimum if a student receives one unit of C unless he also receives one unit of A, or to one who receives more than one unit of C. Additional work is required of a student who does not meet this standard.

If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. The thesis requirement is not waived for research assistants, or, in general, for assistants on research projects.

In the case of candidacy for the degree of Doctor of Philosophy, the thesis subject, approved by the adviser, must be announced at or before the beginning of the third year of study. The student must choose an acceptable subject for his thesis before he can take the preliminary examination.

Before a candidate is admitted to the oral preliminary examination, he is required to pass a series of written preliminary examinations given several weeks in advance of the oral preliminary examination. The examinations need not be based on formal course work alone, but are intended to determine the student's knowledge of his entire field including his knowledge of previous work, history, and practice in his field of specialization.

A candidate for the degree of Doctor of Philosophy is required to pursue a major in the subject in which his research lies. He is also required to choose one or two minor subjects. If one minor only is chosen it must be taken in a department of study other than that of the major, and credit for it may be earned by work representing not less than four units (a total of twenty-four units of graduate work is required for the doctorate). If two minors are chosen, one must be closely related to the major, and the second minor (not less than two units) must be taken in a department of study other than that of the major or first minor. Acceptable minors, unless special permission is granted by petition, are from the following subjects: physical chemistry, analytical chemistry, geology, mathematics, theoretical and applied mechanics, and physics.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in mining and metallurgical engineering may be obtained from the head of the department, 311 Ceramics Building.

In addition to University fellowships, the following industrial fellowships are available to graduate students in mining and metallurgical engineering.

The Union Carbide and Carbon Research Laboratories Fellowship, with an annual stipend of $1,400 to $2,100 (depending upon marital status and previous experience), is awarded to second- and third-year graduate students in metallurgical engineering, as is also the Inland Steel Foundation Fellowship which carries a stipend of $2,400 for the academic year. These fellowships carry exemption from tuition fees.

GRADUATE TEACHING FACULTY

Professors: T. A. Read (Head of Department), P. A. Beck, W. H. Bruckner, E. J. Eckel, W. D. Rose, W. H. Voskuil, C. A. Wert, F. D. Wright.

Associate Professors: R. W. Balluffi, R. W. Bohl, A. C. Forsyth, D. S. Lieberman, M. Metzger, B. G. Ricketts, N. Street, R. M. Thomson, E. K. Weise, R. G. Wuerker.

Assistant Professors: G. R. Eadie, C. M. Wayman.

Mining Engineering

COURSES FOR GRADUATES

401. **Advanced Mineral Dressing and Coal Preparation.** Advanced theory and practice of mineral dressing and coal preparation processes. I or II; 1 unit. Wuerker.

402. **Mine Valuation, Taxation, and Mineral Economics.** A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. I or II; 1 unit. Wright.

403. **Advanced Mine Administration.** Current methods and systems of mine administration in use by major mining corporations. I or II; 1 unit. Staff.

405. **Advanced Mine Ventilation.** Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. I; 1 unit. Eadie.

406. **Design of Underground Openings.** Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. II; 1 unit. Prerequisite: Mining Engineering 253. Wright.

497. **Special Problems.** Individual studies in areas of mining or petroleum engineering, not covered by regular course offerings, carried out under the supervision of a member of the staff. I, II; ½ to 2 units. Prerequisite: Consent of instructor. Staff.

499. **Thesis Research.** Individual research in some phase of the general field of mining or petroleum engineering and under the supervision of a member of the staff. I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **World Mineral Economics.** The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. II; ¾ to 1 unit. Voskuil.

304. **Mine Safety Engineering.** A detailed study of mine accident statistics, causes of accidents, accident prevention; consideration of insurance rates and cost of mine accidents; psychology of accident prevention; state and federal mining laws as related to safety. I; ¾ to 1 unit. Prerequisite: Consent of instructor. Eadie.

351. **Geophysical Prospecting.** Same as Geology 351. Principles of geophysics and their application to mining processes. I; 1 unit. Wuerker.

354. **Mining Geology.** Same as Geology 354. Structure and occurrence of mineral deposits in relation to prospecting, exploration, development, and exploitation. II; 1 unit. Prerequisite: Geology 101 or 150, 130 or 131, and Mining Engineering 201 or 230; or consent of instructor. Wright.

357. **Mine Plant Operation.** Haulage, hoisting, and pumping as related to transportation of men and materials. I; ¾ to 1 unit. Prerequisite: Electrical Engineering 208; Mechanical Engineering 201. WUERKER.

358. **Engineering Properties of Rocks.** Strength and elastic properties of rocks, their determination and utilization in comminution, roof control, and fracturing of wells; discussion of tests in free and confined state; sonic testing; applications to mineral engineering processes, such as drilling and blasting. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or consent of instructor. WUERKER.

371. **Petroleum Production Engineering.** Field development. Properties of petroleum, oil reservoirs, exploration and drilling methods, casing methods, and well logging. I; ½ to ¾ unit. Prerequisite: Consent of instructor.

372. **Petroleum Production Engineering.** Study of reservoir performance, principle of oil and gas recovery, storage and transportation, economics of oil field exploitation. II; ½ to ¾ unit. Prerequisite: Mining Engineering 371. ROSE.

373. **Advanced Reservoir Engineering.** Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. I; ¾ to 1 unit. Prerequisite: Mining Engineering 372 or consent of instructor; Mathematics 345. ROSE.

374. **Recovery of Petroleum.** An advanced treatment of the various methods of petroleum recovery from underground reservoirs, especially emphasizing secondary recovery methods. II; ¾ to 1 unit. Prerequisite: Mining Engineering 372 or consent of instructor. ROSE.

375. **Advanced Petroleum Engineering Laboratory.** Techniques of petroleum engineering research to evaluate the effectiveness of various methods for drilling and completing wells and for recovering petroleum from underground reservoirs. I, II; ¾ to 1 unit. Prerequisite: Mining Engineering 372, senior standing, or consent of instructor. ROSE, STREET.

396. **Seminar.** Review of mining and petroleum literature; reports; technical writing. II; ¼ unit. STAFF.

Metallurgical Engineering

COURSES FOR GRADUATES

405. **Advanced Physics of Metals.** Quantum mechanics and perturbation theory with applications to atoms and free particles in a box; statistics and the free electron theory of metals with an introduction to the band theory of the various types of solids. I; 1 unit. Prerequisite: Mathematics 345, Physics 381, and Metallurgical Engineering 318, or consent of instructor.

406. **Advanced Physics of Metals.** Detailed discussion of the band theory of solids, with applications to the cohesion of metals, electronic specific heats, magnetic susceptibility, and semiconductors; ferro- and anti-ferromagnetism; the modern physical theories of simple alloy structures. II; 1 unit. Prerequisite: Metallurgical Engineering 405 or consent of instructor.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. I; 1 unit. Prerequisite: Consent of instructor. BECK.

408. **Dislocations and Mechanical Properties of Metals.** General static and dynamic properties of single dislocations in crystals; dislocation interactions;

properties of dislocation arrays; role of dislocations in metallurgical phenomena with particular emphasis on mechanical properties. I; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Consent of instructor. BALLUFFI.

409. **Crystal Physics.** The anisotropic properties of crystals treated by tensor and matrix methods with applications to paramagnetism, conduction and diffusion, thermoelectricity, deformation, elasticity, and martensitic transformations. The effects of crystal symmetry and the properties of aggregates are discussed. I; 1 unit. Prerequisite: Vector algebra, determinants, and thermodynamics; consent of instructor. METZGER.

410. **Advanced X-ray Metallography.** X-ray diffraction as applied to the study of metals and alloys; effects of cold work, annealing, substructures, preferred orientation and ordering, principles of electron and neutron diffraction. II; 1 unit. Prerequisite: Chemistry 427 or consent of instructor. BECK.

420. **Metallurgical Thermodynamics.** Fundamental thermodynamic considerations and applications of thermodynamics to metallurgical problems; particular emphasis on heterogeneous equilibrium and thermodynamic properties of solutions; topics approached from the viewpoints of both macroscopic thermodynamics and statistical mechanics. II; 1 unit. Prerequisite: Physics 360 or Chemistry 394 or consent of instructor. BALLUFFI.

421. **Kinetics of Phase Changes in Metals.** Characteristics of phase changes in solids; phenomenological analysis of nucleation and growth; the roles of diffusion, interfacial energy and strain energy; attempts at quantitative treatment of crystallization, eutectoid decomposition, diffusionless phase changes, and precipitation. II; 1 unit. Prerequisite: Consent of instructor. METZGER.

485. **Metallurgical Engineering Problems.** Individual study in areas of metallurgical engineering not covered by regular offerings, carried out under the supervision of a member of the staff. I, II; ½ to 2 units. STAFF.

493. **Seminar on Anelasticity.** Lectures and discussions of the nature of anelasticity and its application to metallurgy. I, II; 0 to ¼ unit. Prerequisite: Consent of instructor. WERT.

494. **Seminar on Phase Transformations in Metals.** Discussion of current research in this field including presentation by graduate students of their own work. I, II; 0 to ¼ unit. Prerequisite: Consent of instructor. LIEBERMAN, READ, WAYMAN.

495. **Seminar on Diffusion and Imperfections.** Lectures and discussions on diffusion and imperfections in crystalline solids. I, II; 0 to ¼ unit. Prerequisite: Consent of instructor. BALLUFFI.

497. **Seminar on Recrystallization and Theory of Alloys.** Graduate students present the results of their own research work and the results of recently published research by other investigators principally in the fields of recovery, subgrains, recrystallization, grain growth, textures, and alloys of the transition elements. I, II; 0 to ¼ unit. Prerequisite: Graduate standing in metallurgical engineering. BECK.

498. **Colloquium in Physical Metallurgy.** Review of current metallurgical research in other laboratories by visiting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. I, II; no credit.

499. **Thesis Research.** Individual research in specialized problems under the supervision of members of the staff. Results of research may be used for graduate thesis. I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Metallurgy of Welding.** A survey is made of existing welding procedures and their metallurgical (ferrous and nonferrous) consequences with respect to the weld and base metal involved thermally in the welding operations. Heat flow in metals, arc behavior, slag behavior, and the physical metallurgy of heat-affected base metal are considered. Engineering phases of welding covered are economics of welding in relation to other methods of joining metals or producing engineering structures, thermal stresses, specification of materials for weld and base metal, and methods of production by means of welding and gas cutting. I or II; ¾ to 1 unit. Prerequisite: Metallurgical Engineering 208 and 210, or consent of instructor. Bruckner.

302. **Powder Metallurgy.** Production and testing of metal powders; fabrication and application of metal shapes produced from metal powders. II; ½ or ¾ unit. Prerequisite: Consent of instructor; registration in Metallurgical Engineering 304. Eckel.

304. **Powder Metallurgy Laboratory.** Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. II; ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302. Eckel.

311. **Advanced Phase Diagrams.** Interpretation and experimental determination of multicomponent phase diagrams with the emphasis on ternary systems. I; ¾ unit. Prerequisite: Equivalent of the undergraduate courses required in metallurgical engineering. Eckel.

318. **Introduction to Metal Physics.** The free electron theory of metals, thermal and electrical conductivities, specific heat, thermo-electric effects, the Hall effect, motions of electrons in a periodic field, the band approximation, semiconductors and transistors, cohesion, ferro-magnetism, thermionic emission; the structure of alloy phases, diffusion in metals, order-disorder, phase precipitation by nucleation and growth. I; ¾ unit. Prerequisite: Chemistry 246, Metallurgical Engineering 209, or consent of instructor. Lieberman.

319. **Elements of the Theory of Alloys.** An introduction to the theory of alloys involving a thermodynamic and structural approach to the understanding of equilibrium diagrams. Topics covered include equilibrium, free energy of alloy phases, equilibrium diagrams, solid solutions, electron compounds, intermediate phases, order-disorder, etc. II; 1 unit. Prerequisite: Metallurgical Engineering 209, Metallurgical Engineering 318, and Chemistry 246. Wayman.

MUSIC

The School of Music offers the degrees of Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Degree of Master of Music. For the degree of Master of Music, the major field may be in musicology, music theory and composition, applied music (organ, voice, piano, violin, viola, cello, solo wind instruments), or band and orchestra instruments.

The admission requirement, in terms of grade-point average, is at least 3.5.

In addition, an applicant for admission to graduate study in music is required (1) to have finished successfully a four-year undergraduate curriculum in music

or music education, or its equivalent in hours and content, from an institution which holds membership in the Association of American Universities, or from a liberal arts college recognized by the North Central Association or equivalent regional accrediting association, or from an independent conservatory or school of music whose four-year undergraduate curricula represent the equivalent in hours, content, and attainment of those offered at the University of Illinois; and (2) to pass a qualifying examination in the major field of concentration to be administered by the graduate committee of the School of Music. If the major is to be applied music or band and orchestra conducting, this examination is essentially one of performance on the major instrument and is given at specified times during the year. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of both German and French is desirable. Each applicant must furnish the graduate committee of the School of Music a copy of his official undergraduate transcript.

Degree of Doctor of Musical Arts. The degree of Doctor of Musical Arts is offered to candidates who are capable of demonstrating that kind of professional competence and artistic independence which results when technical skills and musical talent are supported by a thorough and comprehensive grasp of musical theory, of the history of the musical literature, of the evolution of styles and performance practices, and of the broad spiritual and aesthetic principles which underlie all artistic manifestations. The fields of specialization for the degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree is available to candidates with a major in one of the following fields: composition, piano, organ, violin, cello, and voice.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to the program leading to the degree of Doctor of Musical Arts. The prerequisites for admission are as follows:

(1) The degree of Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent):

(a) Major in Composition: advanced composition, two units; theory, two units; Music 428, Problems and Methods, one unit; electives, three units;

(b) Major in Applied Music: applied music, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) Composition or performance honors awarded to the student on the basis of a program presented in connection with his work toward the master's degree.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) Superior work in Music 428 or its equivalent.

(5) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature, psychology, and philosophy. Students lacking an appropriate background in liberal arts and sciences when applying for admission to the program may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination. The graduate committee of the School of Music reserves the right to require a student to reinforce his preparation in areas which are relevant to his program of study by the successful completion of additional courses in the liberal arts and sciences.

(6) The successful completion of examinations administered by the graduate committee of the School of Music. These examinations include applied music,

theory of music, history of music, and a verbal competence test. An unsatisfactory showing in any of these areas by a student who meets other prerequisites may lead to an acceptance of the student provisionally, but such students are expected to pass these examinations by the end of the first semester of their matriculation in this program (calculated on a full-time residence basis).

After admission to the doctoral program the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, calendar, grades, and major and minor fields.

A minimum of sixteen units of graduate credit beyond the eight units required for the degree of Master of Music is necessary to earn the degree of Doctor of Musical Arts. Of this total, three units are devoted to the completion of a special doctoral project involving the following: for the student majoring in composition, the writing of a representative original score on a large scale; for the student majoring in applied music, the study of a comprehensive repertoire and the presentation of two full-length recital programs including solo and, where appropriate, chamber music works. Two units are devoted to the completion of an original thesis.

In addition to the foregoing, the work includes the following required courses: composition or applied music, three units; Music 420, Seminar in Music Literature for Doctoral Candidates, two units. One unit of work must be taken in the field of education or music education. At least two, but no more than four, units are devoted to an outside minor field. The outside minor field may be history, philosophy, psychology, related arts, English or other literature, sociology, acoustics, journalism, or education. Other minor fields may be accepted upon recommendation of the major adviser.

Of the six units of elective credit available within the total program, including the work toward the master's degree, at least three must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must complete the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College. For eligibility the student must (1) have completed a minimum of eight units of work beyond the master's degree including two units in composition or applied music, two units in Music 420, Seminar in Music Literature, one unit in education or music education, and one unit of the outside minor field; (2) have passed the required language examinations, of which one is in German and one in French, Italian, Spanish, or Russian as designated by the graduate committee, and also in one or more additional foreign languages where, in the opinion of the graduate committee, the knowledge of such language is necessary for proper research in the student's field of concentration; and (3) have received the recommendation of his adviser.

The work to be covered in the final year of study (calculated on a full-time residence basis) is as follows: applied music or composition, one unit; doctoral project, three units; thesis, two units; electives, two units.

After completion of the doctoral project, the thesis, and the remaining course work, and upon recommendation of the graduate committee, the candidate is eligible for his final examination which must be held at least two weeks prior to the date when the degree is conferred. This examination is on the original score or, respectively, on the repertoire numbers, and on the thesis prepared by the candidate, but also covers broader aspects of the general field of music literature, history, and theory. It is conducted by a committee appointed by the Dean of the Graduate College.

Degree of Doctor of Philosophy in Musicology. The degree of Doctor of Philosophy in Musicology is offered in such fields of music as merit and demand research methods. It is intended for applicants whose interest lies in research in

the history of music, theory of music, psychology of music, ethno-musicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College (see page 15), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to the program leading to the degree of Doctor of Philosophy. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the degree of Master of Music with a major in musicology or theory of music; (2) have acquired an adequate background of approximately thirty-two semester hours in the liberal arts and sciences, including general history, philosophy, psychology, and literature; (3) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music, including examinations in applied music, theory of music, history of music, and verbal competence. An unsatisfactory showing in any one of these examinations by an applicant who meets other prerequisites may lead to provisional acceptance, but such students are expected to pass all examinations during their first year of work.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the minimum of twenty-four units of graduate credit necessary to earn the degree of Doctor of Philosophy must be in Music 429 and are devoted to the completion of an original doctoral thesis subsequent to the official admission of the student to candidacy. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or their equivalent, in courses including Music 314, 320, 322, 414, 415, 422, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in applied music. Credit for units not in music is granted toward the Doctor of Philosophy degree only where approved by the graduate committee as relevant to the student's field of specialization.

(2) A minimum of two units each in one or two of the following minor fields: history, philosophy, psychology, related arts, English or other literature, sociology, classics, anthropology, physics (acoustics), electrical engineering, journalism, or education. Other minor fields may be accepted upon recommendation of the major adviser.

(3) In addition to the general foreign language requirements of the Graduate College, an examination in one or more additional foreign languages when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(4) A preliminary examination administered by a committee appointed by the Dean of the Graduate College. This examination consists of a written examination on the history of music; a written examination in the area of the student's field of concentration; the submission, at least a month prior to the written examinations, of a score of a free composition, a fugue, or an instrumentation project of a nature approved by the graduate committee of the School of Music; and an oral examination on the general field of musicology and on the content of the written examinations.

Degree of Master of Science in Music Education. Candidates for the degree of Master of Science in Music Education must earn four units in music, two units in education, and two units in electives. Requirements are electives selected with the approval of the adviser; four units of music and two others; two courses from Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives must be selected with the approval of the adviser. Four elec-

tives must be in music, and the other two in music, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.5. All applicants for admission are required to satisfy a qualifying examination of performance in the principal applied music area.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the degree of Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music theory and applied music to determine the candidate's level of proficiency in those areas. A candidate whose level of proficiency is below that required by the University of Illinois for the Bachelor of Science degree in Music Education is required to take work in addition to the course work prescribed below under "Program."

Residence. The minimum residence requirement is one semester during which a minimum of three units is successfully completed, or two summer sessions during each of which a minimum of two units is successfully completed. All work for the certificate may be completed in summer sessions.

Program. A minimum of eight units of course work beyond the master's degree is required. All of the course work must be taken on the Urbana campus of the University. Music 440 and 441 and either Education 411 or 412 are required. The remainder of the program is based upon the student's needs and interests and upon the deficiencies revealed in placement tests. No more than one unit of applied music may be counted toward the certificate. With the prior approval of an adviser, courses in music which carry undergraduate numbers may be approved for credit. Such credit is computed at the rate of one-fourth unit for each semester hour of credit. No such credit can be counted toward the requirements of the degrees of Master of Science in Music Education and Doctor of Education with a major in music education.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Degree of Doctor of Education. The program leading to the degree of Doctor of Education with a major in music education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations administered by the School of Music include music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in music courses and six units of credit in education courses. No more than one unit of credit in applied music may be counted toward the degree. Students found deficient in applied music are expected to correct the deficiency in addition to the prescribed course work.

The following courses are required: Education 410, 415, Music 421, 440, and 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. Extramural course work may not be included as part of this sixteen-unit requirement. A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the degree of Doctor of Education with a music education major. A student may, with the approval of the advisers, plan a maximum of four units of work to be accomplished at other accredited institutions. No more than six units of credit earned at other universities may be included in the minimum sixteen-unit requirement.

A preliminary examination in music and education must be completed prior to the beginning of the dissertation. A student who has completed a minimum of eight units of course work subsequent to his admission may take the preliminary examination when it is recommended by his advisers. The preliminary examination is given by a committee composed of representatives from the School of Music and the College of Education appointed by the Dean of the Graduate College. The nature of the examination is determined by the committee. Part of the examination may be written. Part of it must be oral. Prior to admission to the preliminary examination the student is expected to demonstrate broad competence in professional education and in music and music education. Competence may be demonstrated by a grade of B or better in appropriate courses or by satisfactory completion of proficiency examinations.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

A final oral examination is held at least two weeks prior to the date the degree is conferred. The examination committee is appointed by the Dean of the Graduate College and should include representatives from both the School of Music and the College of Education. The final examination is primarily concerned with a report of the thesis study, but also extends over the whole field of the candidate's study.

Upon satisfactory completion of all degree requirements in both the School of Music and the College of Education, the candidates are recommended for graduation by the School of Music.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in music may be obtained from the director of the school, 100 Smith Music Hall.

GRADUATE TEACHING FACULTY

Professors: D. A. Branigan (Director of the School of Music), B. Bergethon, Dorothy E. Bowen, H. A. Decker, S. Fletcher, B. R. Foote, S. Goldthwaite, B. Goodman, M. H. Hindsley, H. Kessler, J. M. Kuypers, C. Leonhard, R. H. Miles, P. S. Pettinga, B. Phillips, D. Plamenac, P. Rolland, W. L. Roosa, S. Schoonmaker, S. Stravinsky, G. Waller, Jane C. Watt, Velma K. Wilson, L. E. Zirner.

Associate Professors: G. W. Binkerd, Beth Bradley, J. C. Garvey, L. R. Hamp, K. Kellogg, J. R. Kelly, E. D. Kisinger, A. J. McDowell, P. Painter, Claire L. Richards, H. C. Schmitt, H. O. Sexton, R. H. Swenson, Grace Wilson.

Assistant Professors: A. M. Carter, Dorothy E. Clark, C. O. DeLaney, P. Farrell, R. E. Gray, G. Hunter, Colleen J. Kirk, D. A. Ledet, W. Miller, C. V. Palisca, D. W. Sanders.

Instructors: E. S. Berry, W. Coggins, T. L. Holden, B. B. Johnston, E. Krolick, J. H. McKenzie.

COURSES FOR GRADUATES

400. **Advanced Instrumentation: Chamber and Symphonic.** Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. I; ½ to 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. **Advanced Instrumentation: Band.** Arrange for the concert band works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. II; ½ to 1 unit. Prerequisite: Undergraduate instrumentation. Hindsley.

402. **Analysis in Relation to Performance and Interpretation, I.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. I; 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. Leonhard.

403. **Analysis in Relation to Performance and Interpretation, II.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. II; 1 unit. Prerequisite: Music 402. Leonhard.

406. **Composition.** Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. I, II; ½ to 1½ units. Staff.

410. **History of Music Theory, I.** A study of selected theoretical treatises written before 1400. I; ½ to 1 unit. Palisca.

411. **History of Music Theory, II.** A study of selected theoretical treatises written after 1400. II; ½ to 1 unit. Palisca.

412. **History of Musical Aesthetics, I.** A survey of the principal philosophies of music, their historical backgrounds and their relation to musical styles. From Pythagoreanism to the humanistic period. I; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Graduate standing in music. Palisca.

413. **History of Musical Aesthetics, II.** A survey of the principal philosophies of music, their historical backgrounds and their relation to musical styles. From the seventeenth century to the present day. II; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Music 412. Palisca.

414. **Notation, I.** The history of notation from its beginning to 1400. I; ½ unit. Prerequisite: Consent of instructor. GOLDTHWAITE.

415. **Notation, II.** The history of notation from 1400 to 1600, including instrumental tablatures. II; ½ unit. Prerequisite: Music 414 or consent of instructor. GOLDTHWAITE.

416. **History of Instrumental Music to 1600.** A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. I; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Music 312. PLAMENAC.

417. **History of Instrumental Music from 1600 to 1750.** A study of instrumental music in the Baroque era. II; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Music 416 or consent of instructor. GOLDTHWAITE.

418. **The Origins and the History of Opera up to Gluck.** The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory and aesthetics of opera. The principal composers covered are Monteverdi, Cavalli, Cesti, Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. I; ½ unit. Prerequisite: Music 312. PALISCA.

419. **Mozart.** A study of selected representative works from all fields and periods of Mozart's activity as a composer, with special emphasis on dramatic production. I; 1 unit. Prerequisite: Graduate standing in music or music education. PLAMENAC.

420. **Seminar in Music Literature.** Intensive study of outstanding works selected from all fields of music literature. Required of all students enrolled in the Doctor of Musical Arts program. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. GOLDTHWAITE.

421. **Seminar in Music Education.** An introduction to problems and methods of research in music education. Required of all candidates for the Doctor of Education degree in music education. I or II; 1 unit. Prerequisite: Admission to the doctoral program or consent of instructor. BERGETHON.

422. **Seminar in Theory of Music.** Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. I, II; ½ or 1 unit. KESSLER.

423. **Seminar in Musicology.** Problems in historical and systematic musicology. Discussions of special problems and reports on individual research. I, II; 1 unit. PLAMENAC.

424. **Bach, I.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. I; ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music degree. MILES.

425. **Bach, II.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. II; ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music degree. MILES.

426. **Beethoven, I.** I; ½ or 1 unit. KUYPERS.

427. **Beethoven, II.** II; ½ or 1 unit. KUYPERS.

428. **Problems and Methods.** An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports on bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. I; 1 unit. PALISCA.

430. **Advanced Orchestra Conducting and Literature.** Intensive study of conducting techniques and problems related to standard orchestral literature. Includes a survey of materials for school and community orchestras. I or II; 1 unit. Prerequisite: Previous conducting experience. BERGETHON.

431. **Advanced Band Conducting and Literature.** I; 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Techniques.** An intensive laboratory approach to the development of advanced techniques necessary for working effectively with choral ensembles. I, II; 1 unit. Prerequisite: Graduate standing in music. KIRK.

433. **Advanced Choral Literature and Conducting.** An intensive survey of choral literature with laboratory organization for reading, conducting, and interpretation of choral music of all periods, styles, and voice arrangements. I or II; 1 unit. Prerequisite: Graduate standing in music; Music 432 or equivalent; consent of instructor. DECKER.

434. **Piano Literature.** I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. KESSLER.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. KELLOGG, REEVES.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. MILES.

437. **String Instrument Literature.** I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. ROOSA.

438. **Wind Instrument Literature.** An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance when possible, of the music itself, recordings, and collateral readings. I, II; 1 unit; maximum accumulated credit, 2 units. KISINGER, LEDET.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. I; ½ unit. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. II; ½ unit. LEONHARD.

442. **The General Music Program in Secondary Schools.** A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. I or II; ½ unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. **Administration and Supervision of Music Education.** Deals with the functions of supervisors and directors of music education in administering music programs in elementary and secondary schools. I or II; ½ unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

445. **Music in Higher Education.** An orientation to the organization, teaching, and administration of music in the college and university. I or II; ½ unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

446. **Seminar and Laboratory in Musical Acoustics, I.** Physics of sound with emphasis on application to electrical techniques of music reproduction and propagation, and audio-visual aids. I; ½ or 1 unit. Prerequisite: Graduate standing in music or music education, or consent of instructor.

447. **Seminar and Laboratory in Musical Acoustics, II.** Continuation of Music 446. Modern experimental electronic music and music theory. Individual projects for selected students. II; ½ or 1 unit. Prerequisite: Music 446.

480. **Piano.** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

481. **Voice.** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

482. **Organ.** Selected studies from the masterworks of organ literature. I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

483. **Violin.** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

484. **Cello.** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. STAFF.

489. **Doctoral Projects.** Special projects for candidates for the degree of Doctor of Musical Arts. Open only to students in the Doctor of Musical Arts program. I, II; 1 to 3 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** Research in special projects. I, II; 0 to 4 units. Prerequisite: Consent of adviser. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Counterpoint, I.** Creative writing in linear counterpoint of the following: rounds, instrumental and vocal; canons; inventions; and fugues. Analysis of Bach *Inventions* and the *Well-Tempered Clavier.* I; ½ unit. Prerequisite: Music 104. JOHNSTON.

301. **Advanced Counterpoint, II.** Creative writing in linear counterpoint of the following: rounds, instrumental and vocal; canons; inventions; and fugues. Analysis of Bach *Inventions* and the *Well-Tempered Clavier.* II; ½ unit. Prerequisite: Music 300. JOHNSTON.

302. **Fugue, I.** Systematic practice in writing the various parts of the fugue, together with analysis of fugues by Bach and Handel. I; ½ unit. Prerequisite: Music 104 and/or consent of instructor. JOHNSTON.

303. **Fugue, II.** Continuation of Music 302, including the writing of complete fugues and analysis of fugal composition of the nineteenth and twentieth centuries. II; ½ unit. Prerequisite: Music 302 and/or consent of instructor. JOHNSTON.

304. **Analytical Techniques, I.** Examination of music from plain song and the earliest polyphony to the close of the sixteenth century. Emphasis is placed upon penetration of the compositional techniques used and includes the study of form and harmony as these bear on the problems. I; ½ unit. Prerequisite: Music 104 or consent of instructor. PHILLIPS.

305. **Analytical Techniques, II.** Continuation of Music 304, beginning with the early seventeenth century and coming down to the present day. II; ½ unit. Prerequisite: Music 304 or consent of instructor. PHILLIPS.

306. **Composition.** Work in original composition including the small and large homophonic forms. I, II; ½ or 1 unit. Prerequisite: Music 104 or 106 or consent of instructor. JOHNSTON.

307. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. Through study and singing, seeks familiarization with the styles of Dunstable, Dufay, Obrecht, Okeghem, Gombert, DesPres, Lassus, and Palestrina. Writing is based on results of the study of these composers' works. I; ½ unit. Prerequisite: Consent of instructor. BINKERD, JOHNSTON.

308. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Continuation of Music 307. II; ½ unit. Prerequisite: Music 307. BINKERD, JOHNSTON.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. I; ½ unit. Prerequisite: Music 112. PALISCA.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. II; ½ unit. Prerequisite: Music 310. PALISCA.

312. **Music of the Baroque and Classical Periods.** A history of music from about 1600 to 1800. I; ½ unit. Prerequisite: Music 311. ROOSA.

313. **Music of the Nineteenth and Twentieth Centuries.** A history of music from about 1800 to the present. II; ½ unit. Prerequisite: Music 312. ROOSA.

315. **Contemporary Music.** A survey of all important trends, forms, and styles of modern music from 1875 to the present. I, II; ½ unit. Prerequisite: Consent of instructor. KUYPERS.

318. **History of Performance Practices, I.** The study of musical performance from about 900 to 1650 A.D. Discussion of musical instruments, make-up of instrumental and vocal ensembles, etc., are supplemented by demonstration performances of selected works using the University's collection of instruments. I; ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

319. **History of Performance Practices, II.** The study of musical performance from 1600 to 1750 A.D. Discussion of musical instruments, ornamentation, basso continuo, etc., are supplemented by demonstration performances using the University's collection of instruments. II; ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

320. **Proseminar.** Provides special preparation in specialized fields of musicology, music education, theory, and composition. I, II; ½ or 1 unit; maximum credit, 2 units. Prerequisite: Senior or graduate standing in music or music education and consent of instructor. PLAMENAC and staff.

322. **Introduction to Musicology.** A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. I, II; ½ unit; maximum accumulated credit, 1 unit. GOLDTHWAITE, PLAMENAC.

330. **Applied Music Pedogogy.** Survey of techniques, practices, and materials. Presentation of group and individual instruction. An approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. I, II; ½ unit; maximum accumulated credit, 1 unit. BRADLEY, FLETCHER, ROLLAND.

332. **Church Music Literature.** Survey of the development of church music with emphasis on the period since 1500. I; ½ unit. Prerequisite: Music 214 or 311, or consent of instructor. PETTINGA.

333. **Church Music Techniques.** The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. II; ½ unit. Prerequisite: Music 332 or consent of instructor. PETTINGA.

340. **Instrumental Clinic and Band Pageantry.** A study of the peculiarities of the individual instruments, criteria for selection, and accepted teaching methods and procedures for each instrument. Band pageantry deals with formation designing, charting and show continuity, marching fundamentals, and special problems. I; ½ unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

341. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. II; 1 unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

342. **Percussion Methods.** Designed primarily for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. I or II; ½ unit. MCKENZIE.

344. **Methods of String Class Teaching.** Designed primarily for teachers of school music who are not performers on a string instrument yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Consent of instructor. WALLER.

345. **Teaching Techniques of Music Theory.** Techniques and materials used in the teaching of theory of music in senior high school and junior college. I; ½ unit. Prerequisite: Music 300 or consent of instructor. CARTER.

346. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools. S; ½ or 1 unit. Prerequisite: One year of teaching experience or consent of instructor. BERGETHON, LEONHARD.

347. **Teaching of Woodwind Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1958 and in alternate years. Prerequisite: Senior or graduate standing in music education, or consent of instructor. MCDOWELL.

348. **Teaching of Brass Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1959 and in alternate years. SEXTON.

350. **Advanced Chamber Music.** Selected projects in chamber music on the advanced level for qualified students. I, II; ½ unit. Prerequisite: Applied music on the 300 level and consent of instructor. GARVEY and staff.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

380. **Piano.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BRADLEY, FLETCHER, RICHARDS, SCHOONMAKER, STRAVINSKY, WATT, ZIRNER.

381. **Voice.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BAILEY, BOWEN, CLARK, FOOTE, HAMP, KELLOGG, MILLER, WILSON.

382. **Organ.** I, II; ½ or 1 unit. S; ¼ or ½ unit. MILES, PETTINGA.

383. **Violin.** I, II; ½ or 1 unit. S; ¼ or ½ unit. ROLLAND, SCHMITT.

384. **Viola.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GARVEY.
385. **Cello.** I, II; ½ or 1 unit. S; ¼ or ½ unit. FARRELL, SWENSON.
386. **String Bass.** I, II; ½ or 1 unit. S; ¼ or ½ unit. KROLICK.
387. **Flute.** I, II; ½ or 1 unit. S; ¼ or ½ unit. DELANEY.
388. **Clarinet.** I, II; ½ or 1 unit. S; ¼ or ½ unit. MCDOWELL.
389. **Oboe.** I, II; ½ or 1 unit. S; ¼ or ½ unit. LEDET.
390. **Bassoon.** I, II; ½ or 1 unit. S; ¼ or ½ unit. BERRY.
391. **Cornet and Trumpet.** I, II; ½ or 1 unit. S; ¼ or ½ unit. SEXTON.
392. **French Horn.** I, II; ½ or 1 unit. S; ¼ or ½ unit. HOLDEN.
393. **Trombone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GRAY.
394. **Baritone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GRAY.
395. **Tuba.** I, II; ½ or 1 unit. S; ¼ or ½ unit. GRAY.
396. **Percussion.** I, II; ½ or 1 unit. S; ¼ or ½ unit. MCKENZIE.
397. **Harp.** I, II; ½ or 1 unit. S; ¼ or ½ unit.
398. **Saxophone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. COGGINS.
399. **Harpsichord.** I, II; ½ or 1 unit. S; ¼ or ½ unit. HUNTER.

PHILOSOPHY

The Department of Philosophy offers graduate work leading to the Master of Arts and Doctor of Philosophy degrees.

Students undertaking graduate work with philosophy as their major subject must have had a grade-point average of at least 3.75. In addition, students majoring in philosophy should have had a course in logic, a course in ethics, and a general course in the history of philosophy. Students with deficiencies are required to fill them by taking Philosophy 102 (or 333), 321, or 303-306, respectively, in addition to the minimum requirement of eight units for the master's degree.

Degree of Master of Arts. A candidate for this degree must choose at least one course in each of the following three fields: history of philosophy; theory of knowledge, including logic and philosophy of science; and theory of value, including ethics and aesthetics. In addition to completing eight units of graduate work, the candidate must take an oral examination on the work represented by these units. His adviser arranges and presides at this examination. Applications to have the thesis requirement waived are not approved except on recommendation of the adviser and vote of the department.

Degree of Doctor of Philosophy. A candidate for this degree carries on (1) major studies in one of the three fields within the department; (2) minor studies amounting to at least two units in each of the two remaining fields; and (3) minor studies amounting to at least two units in a department other than philosophy. The three fields within the Department of Philosophy are history of philosophy; theory of knowledge, including logic and philosophy of science; and theory of value, including ethics, social philosophy, and aesthetics. The candidate's choice of major and minors must be approved by the department.

The preliminary examination for the doctor's degree, in addition to the major and minor subjects, presupposes first-hand acquaintance with at least one major work of Plato, Aristotle, Augustine or Aquinas, Descartes, Spinoza, Leibniz, Locke, Berkeley, Hume, Kant, and Hegel.

The details of the special departmental requirements for graduate degrees can be obtained in mimeographed form by addressing a request to the Department of Philosophy, 119 Lincoln Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assitantships in philosophy may be obtained from the chairman of the department, 119 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: D. W. Gotshalk (Chairman of Department), M. H. Fisch, A. R. Turquette, F. L. Will.

Associate Professors: B. J. Diggs, O. A. Kubitz, L. Linsky, W. E. Schlaretzki (Visiting).

Assistant Professors: P. Diesing, H. Harris, D. Shwayder, H. M. Tiebout.

COURSES FOR GRADUATES

401. **Seminar in Ancient Philosophy.** I; 1 unit.

402. **Seminar in Ancient Philosophy.** II; 1 unit. Fisch.

403. **Seminar in Medieval Philosophy.** I or II; 1 unit. Diggs.

405. **Seventeenth Century Continental Thought (Descartes, Spinoza, Leibniz).** A study of the basic philosophical works of the three leading continental thinkers of the century. I or II; 1 unit.

407. **British Empiricism.** I or 11; 1 unit. Turquette.

408. **German Idealism (Kant).** I or II; 1 unit. Gotshalk.

409. **Recent American Philosophy.** Major American philosophers and movements since about 1900. Reports and discussions. I or II; 1 unit. Fisch.

411. **Seminar in Recent Ethical Theory.** I or II; 1 unit. Diggs, Fisch.

412. **Seminar in Social Philosophy.** A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. Students may receive credit more than once. I or II; 1 unit. Diggs.

413. **Logical Theory.** I or II; 1 unit. Prerequisite: A course in logic or consent of instructor. Turquette.

420. **Seminar in Semantics.** Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. I or II; 1 unit. Linsky.

421. **Seminar in Contemporary Problems.** Intensive study of selected problems on topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. I or II; 1 unit. Will.

422. **Seminar in Contemporary Problems.** Intensive study of selected problems on topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. I or II; 1 unit. Fisch, Will.

423. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. I; 1 unit. Will.

424. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. II; 1 unit. Will.

430. **Seminar in Modern Aesthetics.** I or II; 1 unit. Gotshalk.

483. **Individual Topics.** I, II; ½ to 2 units. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **History of Greek and Roman Philosophy.** I; 1 unit. Fisch.

304. **History of Medieval Philosophy.** Lectures and readings in the history of philosophy from St. Augustine to William of Ockham. II; ¾ to 1 unit. Prerequisite: Philosophy 101 or 303, or consent of instructor. Diggs.

306. **History of Modern Philosophy.** II; 1 unit. GOTSHALK.

309. **The Philosophy of Plato.** I; ¾ to 1 unit. Prerequisite: Philosophy 101 or 303.

311. **Philosophic Ideas of the Nineteenth and Twentieth Centuries.** I, II; ¾ to 1 unit. HARRIS, TIEBOUT.

313. **American Philosophy.** The history of philosophy in America from colonial times to the present. II; ¾ to 1 unit. Prerequisite: One course in philosophy. FISCH.

317. **Great Books in Modern Thought.** Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. I; ¾ to 1 unit. Prerequisite: One course in philosophy. WILL.

319. **Philosophical Ideas in Latin America.** A survey of the main philosophical currents and thinkers of Latin America. I; ½ to 1 unit. Prerequisite: One course in philosophy or consent of instructor. KUBITZ.

321. **Ethics and Value Theory.** I; ¾ to 1 unit. Prerequisite: One course in philosophy. DIGGS, FISCH.

323. **Philosophy of Art.** A discussion of the main philosophical principles of art and of outstanding contemporary philosophies of art. I; ¾ to 1 unit. GOTSHALK.

324. **Philosophy of Religion.** II; ¾ to 1 unit. Prerequisite: One course in philosophy.

326. **Metaphysics.** II; ¾ to 1 unit. Prerequisite: One course in philosophy. LINSKY.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. I; ¾ to 1 unit. Prerequisite: One course in philosophy. TURQUETTE.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. II; ¾ to 1 unit. Prerequisite: One course in philosophy. WILL.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method, and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. I, II; ¾ to 1 unit. Prerequisite: One course in philosophy. LINSKY, WILL.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. I; ¾ to 1 unit. TURQUETTE.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. II; ¾ to 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Philosophy 333 or consent of instructor. TURQUETTE.

336. **Philosophy of Law and of the State.** II; ¾ to 1 unit. Prerequisite: One course in philosophy. DIESING.

337. **Semantics.** An investigation of semantical concepts such as denoting and truth. A study of the functions of language, definition, meaning and verification, semantical paradoxes. I; ¾ to 1 unit. Prerequisite: One course in philosophy. LINSKY.

340. **The Philosophy of Alfred North Whitehead.** An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas,* taking into account both the cosmological scheme

and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. II; ¾ to 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

350. **Philosophy and Modern Life.** A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. I or II; ¾ to 1 unit. Prerequisite: One course in philosophy. GOTSHALK.

361. **Comparative Religions: The Religions of the East.** A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. I; ¾ to 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

362. **Comparative Religions: The Religions of the West.** A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity, and Islam. II; ¾ to 1 unit. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

363. **Contemporary Religious Thought.** An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. I; ¾ to 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

PHYSICAL EDUCATION

The department offers programs of graduate study leading to the degrees of Master of Science and Doctor of Philosophy in Physical Education. Both programs are centered in training teachers, administrators, and research workers in the general field of physical education, including sport, dance, and exercise, but also offer opportunities for training in the related fields of health education, safety education, and recreation. (See Health and Safety Education, page 154, and Recreation, page 249.)

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for the last two years of undergraduate study; (2) thirty hours of approved undergraduate credit in physical education or related fields; (3) eighteen hours of approved undergraduate credit in science; (4) sixteen hours of undergraduate credit in education; and (5) a course in statistics or measurement.

Degree of Master of Science. Graduation requirements for this degree are eight units to include (1) four units of credit in physical education or related courses (health education or recreation); (2) two units of credit in education including two of the following: Education 301, 302, 303, 304; and Education 311 and 312; (3) registration in and satisfactory completion of Physical Education 490 for one semester, no credit; (4) presentation of an acceptable thesis, two units.

Candidates may petition to waive the thesis and seminar requirements. Those who are excused are required to secure two units' credit in lieu of thesis credit (item 4) and in addition are required to take and pass a final comprehensive written examination in physical education and related fields.

Degree of Doctor of Philosophy. Graduation requirements for this degree are twenty-four units of graduate credit (equivalent of ninety-six hours of credit) including (1) a minimum of eight units of credit in physical education courses or related courses in health education, safety education, or recreation, (2) one minor

for a minimum of four units, or two minors for a minimum of two units each, (3) registration in and satisfactory completion of Physical Education 490, and (4) presentation of an acceptable thesis for approximately eight units.

Each candidate must pass a reading examination in French and German. No student is considered as beginning his second year of graduate work until he has passed one of these examinations. Both examinations must be passed before taking the preliminary examination.

Each candidate must pass a written examination covering his major field of study and an oral examination covering his major and minor fields of study. This preliminary examination is given toward the end of the second year of study or, by special permission, at the beginning of the third year.

Each candidate must pass a final examination, principally on his thesis. This examination must be taken at least two weeks before the degree is to be conferred.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in physical education may be obtained from the dean of the college, 107 Huff Gymnasium.

GRADUATE TEACHING FACULTY

Professors: S. C. Staley (Dean of the College of Physical Education), T. K. Cureton, Laura J. Huelster, C. O. Jackson, H. E. Kenney, C. S. Knapp.

Associate Professors: A. W. Hubbard, R. H. Johnson.

Assistant Professors: Anne E. Jewett, R. E. Shelton, Olive G. Young.

COURSES FOR GRADUATES

401. **Problems in Physical Education.** Biological, physiological, social, psychological, and other purposes and outcomes; selection and distribution of activities; teaching methods; facilities; teacher preparation; literature; research problems. I or II; 1 unit. Huelster, Jackson, Johnson, Kenney.

406. **Philosophy of Sport.** History of sport; cultural, educational, economic, health character, personality, military, therapeutic, and other implications; types and extent of participation; organization; literature; research programs. I or II; 1 unit. Jackson, Johnson, Kenney.

407. **Sport Psychology.** Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, perception and emotion in sport situations; review of literature; independent projects. I or II; 1 unit. Prerequisite: Psychology 100; Education 211; consent of instructor. Hubbard.

408. **Principles of Kinesiotherapy.** Analysis of medically approved techniques employed in the treatment of disease and injury by exercise and movement; kinesiological evaluation of principles involved; therapy preparation in teaching techniques; medically prescribed clinical training; literature; research. I, II; 1 unit. Prerequisite: Anatomy, physiology, kinesiology, and physiology of exercise, or consent of instructor. Shelton.

450. **Trends and Techniques in Rehabilitation.** Philosophy of rehabilitation; education of the handicapped (blind and partially sighted, deaf and hard of hearing, mentally handicapped, socially maladjusted, crippled, cardiac, epileptic, speech deviate, etc.); state, federal, and community education and vocational training programs; literature; research. I or II; 1 unit. Stafford.

451. **Scientific Foundations of Physical Fitness.** Scientific basis for physical fitness; analysis of fitness programs; analysis of fitness tests; techniques in

remedial clinics; literature; research. Includes laboratory session. I or II; 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. CURETON.

452. **Scientific Analysis of Physical Education Activities.** Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. I or II; 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. CURETON.

453. **Anthropometrical and Body Mechanics Research Techniques.** Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. I; 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. CURETON.

490. **Seminar.** Presentation and criticism of student theses; lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders. I, II; no credit. CURETON, HUBBARD, JACKSON, JOHNSON, STAFFORD.

493. **Research.** Independent research on special projects. Open only to students working toward the doctor's degree. I, II; ½ to 2 units. STAFF.

495. **Techniques of Research in Health, Physical Education, and Recreation.** Review and appraisal of common research procedures; application of statistical procedures, library methods, evaluation procedures, and experimental methods. I or II; 1 unit. CURETON, HUBBARD.

499. **Thesis Research.** Preparation of theses in physical education. I, II; 0 to 4 units. STAFF.

PHYSICAL SCIENCES

A special program leading to the degree of Master of Science in the Physical Sciences is available to meet the needs of students who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit carry credit toward the degree. To qualify for the degree, a student must have had, or must include in his program, at least one course in mathematics beyond calculus, and for which calculus is prerequisite.

Candidates for the degree of Master of Science in the Teaching of the Physical Sciences must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in the physical sciences and the electives must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 3.5. The adviser for candidates for this degree is Professor L. F. Audrieth, 355c Noyes Laboratory.

PHYSICS

The Department of Physics offers graduate work leading to the Master of Science and Doctor of Philosophy degrees.

There is opportunity for specialization in nuclear physics, including research with the betatrons, the cyclotron, and with radioactive sources; in nuclear magnetic resonance; in cosmic rays; in theoretical physics; in the physics of solids, including research on ionic crystals, metals, semi-conductors, cryogenics, and surface physics.

The requirements for admission to the Graduate College with a major in physics are twenty semester hours in physics, including Physics 321, 341, and 342 or the equivalent, and excluding courses in general physics and other courses numbered below 270, and a grade-point average of at least 3.75. Students who lack some of the prerequisite courses may be admitted but are required to take the prerequisite courses without graduate credit.

The requirements for the Master of Science degree in physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the degree of Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department. This pamphlet also contains more detailed descriptions of the courses in physics and related courses in mathematics and suggests appropriate course sequences.

Candidates for the degree of Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Education 311, 312, and one additional unit in education selected from Education 301, 302, 303, and 304. Students applying for admission must have a grade-point average of 3.5. The adviser for candidates for this degree is Professor G. M. Almy, 205 Physics Laboratory.

For information concerning applied mathematics, see page 196.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in physics may be obtained from the head of the department, 205 Physics Laboratory.

GRADUATE TEACHING FACULTY

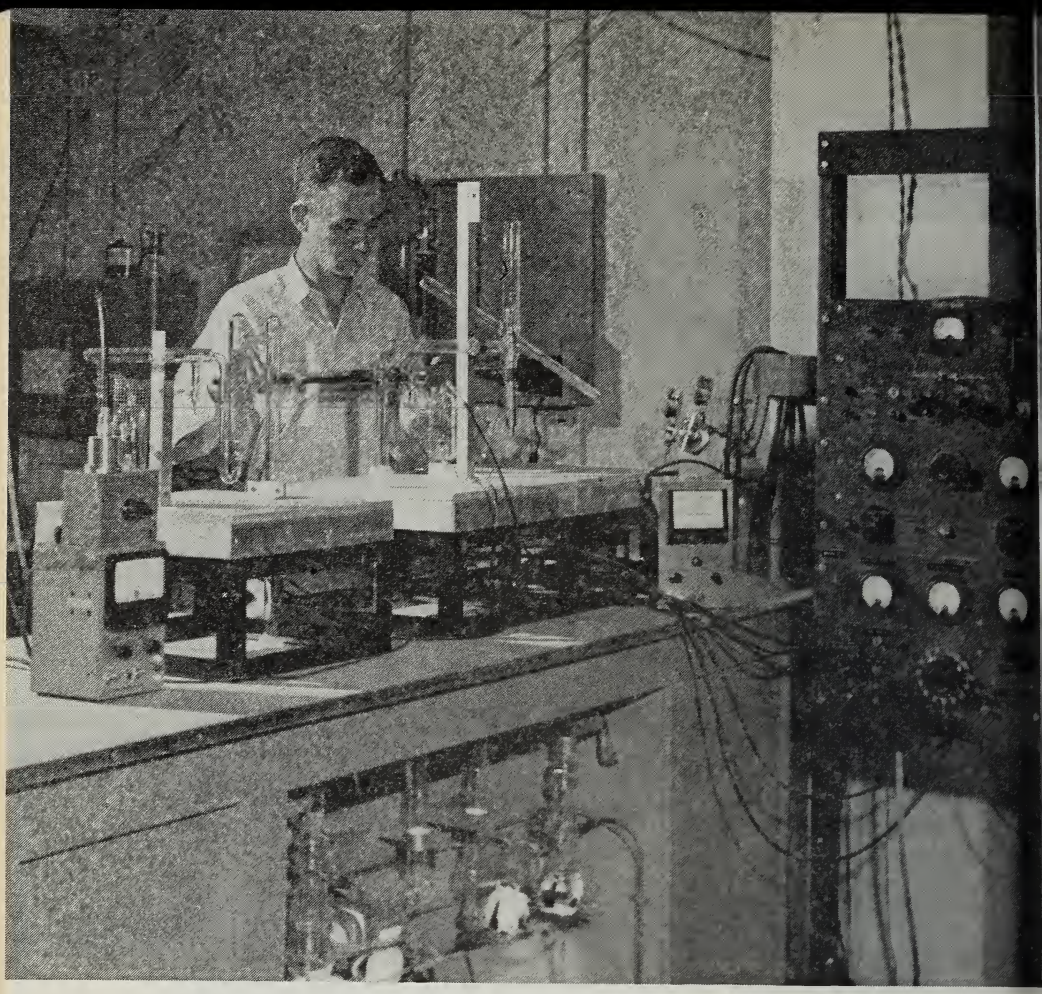
Professors: F. Seitz (Head of Department), J. S. Allen, G. M. Almy, J. Bardeen, J. H. Bartlett, R. A. Becker, G. Bernardini, A. O. Hanson, R. D. Hill, R. I. Hulsizer, J. S. Koehler, P. G. Kruger, F. W. Loomis, E. M. Lyman, R. J. Maurer, R. E. Meagher, A. T. Nordsieck, C. S. Robinson, C. W. Sherwin, C. P. Slichter.

Associate Professors: P. Axel, H. E. Frauenfelder, E. L. Goldwasser, J. D. Jackson, L. S. Lavatelli, D. Lazarus, D. E. Mapother, J. N. Snyder.

Assistant Professors: G. Ascoli, F. C. Brown, R. Novick, L. J. Koester, D. G. Ravenhall, J. H. Smith, J. C. Wheatley, H. W. Wyld.

COURSES FOR GRADUATES

400. Problems and Methods of Theoretical Physics. Vector analysis. Boundary value problems. The equations of mathematical physics; variational derivation; contour integration; ordinary differential equations; boundary conditions; Green's functions; Eigen-functions; Laplace's and Poisson's equations in one, two, and three dimensions; conformal mapping; integral representa-



A graduate student in physics investigates surfaces of metals under extremely high vacuum.

tion; asymptotic expansions. I; 1 unit. Prerequisite: Mathematics 342, 345, 347, or 387; Physics 322 and 342; or consent of instructor.

422. **Dynamics.** LaGrange equations, small vibrations; Hamilton's canonical equations; Hamilton's principle, least action; contact transformations; Hamilton-Jacobi equation; perturbation theory; non-linear mechanics. II; 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. **Relativity and Cosmology.** Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. McVittie.

435. **Conduction of Electricity in Solids.** Same as Electrical Engineering 435. Application of quantum principles to conduction of electricity in solids, impurity and intrinsic semiconductors, Hall and thermoelectric effects, photoconductivity, p-n junctions and rectifying contacts, theory and characteristics of transistors. II; 1 unit. Prerequisite: Physics 381 or Electrical Engineering 425 or consent of instructor. Bardeen.

436. **Selected Topics in Physics of Solids.** The following topics are offered one each semester, normally in a two-year sequence:

(a) **Imperfections in Metals.** Influence of point imperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, physical properties on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) **Imperfections in Ionic Crystals.** Theory of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the electronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.

(c) **Advanced Quantum Theory of Solids.** Theory of electrons in crystals on basis of Bloch theory and Brillouin zone structure with applications to various problems such as cohesive energy of metals, magnetic properties and the de Haas-van Alphen effect, optical properties, spin orbit interactions, excitons and energy transfer. 1 unit. Prerequisite: Physics 486 and 490.

(d) **Conduction in Metals and Semiconductors.** Electrical and thermal conduction, transverse effects, magneto-resistance, vibrational motion and electron-lattice interactions, semiconductors, superconductivity. 1 unit. Prerequisite: Physics 485 and 490.

441. **Electrodynamics.** Electrostatics; Poisson's equations; Laplace's equation; boundary value problems; spherical harmonics; multipole potentials; dielectrics; microscopic and macroscopic fields; susceptibility; magnetostatics: vector potential, magnetic multipoles; magnetic media: ferro-, dia-, paramagnetism; conducting media; Maxwell's equations: field energy and momentum; retarded potentials; fields due to moving charges: Lienard-Wiechert potential, fields of an accelerated charge. I; 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor.

442. **Electrodynamics.** Continuation of Physics 441. Self force of a finite electron; multipole radiation; propagation of radiation in material media: wave guides, modes of propagation, skin effect; special relativity; Lorentz-Abraham electron. II; 1 unit. Prerequisite: Physics 441.

463. **Statistical Mechanics.** Statistical ensembles; the Maxwell-Boltzmann law; approach to equilibrium; quantum statistical mechanics; application of statistical mechanics to thermodynamic processes. I; 1 unit. Prerequisite: Physics 422; Physics 360 or 362.

464. **Dynamics of the Earth's Atmosphere.** Same as Astronomy 464 and Mathematics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

481. **Line Spectra and Atomic Structure.** A lecture and problem course presenting the experimental basis for quantum theory, an introduction to wave mechanics, and applications to atomic and molecular structure. Topics include photoelectric effect, Planck's law of radiation, electron and neutron diffraction, simple and complex atomic spectra, X-ray spectra, hyperfine structure, molecular structure and molecular spectra. I or II; 1 unit. Prerequisite: Physics 322 and 342.

483. **Nuclear Physics.** Basic properties of nuclei; principles of high energy accelerators, particle and radiation detectors, and of precision measuring apparatus; alpha-, beta-, and gamma-decay of nuclei; nuclear masses and systematics of nuclei; nuclear models. I; 1 unit. Prerequisite: Physics 481.

484. **Nuclear Physics.** Nuclear reactions and nuclear models; fission; nuclear scattering and nuclear forces; high energy nuclear physics; meson production and interactions; unstable heavy particles; electro-magnetic interactions. II; 1 unit. Prerequisite: Physics 483.

485. **Quantum Mechanics.** Schrödinger wave equation, stationary state solutions; operators and matrices; perturbation theory, non-degenerate and degenerate cases; WKB approximation, non-harmonic oscillator, etc.; collision problems, Born approximation, method of partial waves. I; 1 unit. Prerequisite: Physics 481 and 422; Physics 400 or consent of instructor.

486. **Quantum Mechanics.** Time dependent perturbation theory, elastic and inelastic scattering, absorption of light; wave functions for identical particles, quantum statistics; Pauli spin operator; classification of atomic states; Thomas-Fermi model; quantization of radiation field; interaction of light with matter; Dirac electron theory. II; 1 unit. Prerequisite: Physics 485.

487. **Topics in Advanced Quantum Theory.** The following topics are offered alternately, each not oftener than once in three semesters.

(a) **Advanced Quantum Mechanics.** Quantum theory of scattering: boundary conditions, S-matrix and reactance matrix; application of symmetry principles: Lorentz and gauge invariance, time reversal, charge conjugation; many-body problems. I or II; 1 unit. Prerequisite: Physics 486.

(b) **Quantum Electrodynamics.** Field quantization; scalar meson field; Dirac electron, electron-positron theory; electrons in external fields; interacting electrons and photons: transition probabilities, Lamb shift, S-matrix and Feynman graphs, Moeller and Compton scattering, electron self-energy, renormalization, anomalous electron magnetic moment. I or II; 1 unit. Prerequisite: Physics 486.

488. **Topics in Theoretical Nuclear Physics.** The following topics are offered:

(a) **Nuclear Structure and Transformations.** The two-nucleon problem; interaction of electromagnetic radiation with nuclei; beta decay; theory of nuclear reactions. I or II; 1 unit. Prerequisite: Physics 484 and 486.

(b) **Mesons and High-Energy Nuclear Physics.** Basic properties of pi-mesons and other sub-nuclear particles; production, absorption, and scattering of pi-mesons; meson theory of nuclear forces; scattering of gamma rays by

nucleons; high-energy reactions in complex nuclei. I or II; 1 unit. Prerequisite: Physics 484 and 486.

489. **Theory of Solids.** Reviews the introductory phases of the modern theory of crystalline materials. Topics treated include the classical theory of ionic crystals, specific heats, electron theory of metals and semi-conductors, the band approximation. I; 1 unit. Prerequisite: Physics 360, 362, 381, or consent of instructor.

490. **Theory of Solids. Continuation of Physics 489.** The electronic structure of solids, optical and magnetic properties, crystal lattice imperfections, diffusion and ionic conductivity, cooperative phenomena, superconductivity. II; 1 unit. Prerequisite: Physics 489, or consent of instructor.

498. **Seminar.** A course number used for credit in individual but supervised study of a subject not covered by regular courses. I, II; 1 to 2 units.

499. **Thesis Research.** I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. **Theoretical Mechanics.** Laws of motion, vectors, statics, energy and momentum principles for a particle and for systems of particles, motion of a particle under constant forces, plane motion of a rigid body, simple harmonic motion and resonance, impact. Lectures and problems. Physics 321 and 322 are fundamental to many advanced courses, and should be elected as early as possible by those intending to specialize in physics. I, II; 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics and calculus.

322. **Theoretical Mechanics.** Continuation of Physics 321. Motion of a particle under a variable force, central field motion, accelerated reference systems, motion of a particle subject to constraints, rotation of a rigid body in three dimensions, vibrating systems and normal coordinates, generalized coordinates. I, II; 1 unit. Prerequisite: Physics 321.

341. **Electricity and Magnetism.** Fundamental laws logically developed and summarized in Maxwell's equations; forces and energies associated with electric and magnetic properties of matter; generation and propagation of electromagnetic waves. Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. I; ½ to 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics and calculus; registration in Mathematics 341 or 343, or consent of instructor.

342. **Electricity and Magnetism.** Continuation of Physics 341. Boundary conditions and special methods in boundary value problems; interpretation of dielectric and magnetic properties of matter from the point of view of atomic and crystalline properties; use of complex notation in circuit problems; coupled circuits; non-linear circuits, transmission lines; radiation from antennas; transmission and reflection of electromagnetic waves. II; ½ to 1 unit. No credit is given to graduate physics majors. Prerequisite: Physics 341.

343. **Vacuum Tube Circuits.** The physics of vacuum tubes, rectifiers and cathode-ray tubes and associated circuits; elementary theory and applications of vacuum tubes as linear circuit elements in amplifiers and electronic instruments. Emphasis is on experimental techniques. Lectures, problems, and laboratory. II; 1 unit. Prerequisite: Physics 341.

344. **Vacuum Tube Circuits.** Continuation of Physics 343. Electronic instruments and techniques used in research in physics: advanced theory and experiments emphasizing the use of vacuum tubes as non-linear circuit ele-

ments, e.g., multi-vibrators, blocking oscillators, pulse generators and amplifiers, geiger counter circuits, synchronizing and time-measuring circuits, and introduction to transistor circuitry. I; 1 unit. Prerequisite: Physics 343 or equivalent.

360. **Thermodynamics.** The first, second, and third laws of thermodynamics; the properties of the entropy, enthalpy, free energy, and internal energy functions; reversible and irreversible processes; applications to homogeneous and heterogeneous systems; chemical reactions and the mass action law. Lectures and problems. I, II; 1 unit. Prerequisite: General physics and calculus.

362. **Kinetic Theory and Statistics.** A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and applications. I, II; 1 unit. Prerequisite: Physics 360 or consent of instructor.

371. **Light.** Geometrical optics: image formation, thick lens theory, aberrations, photometry of optical systems, optical instruments; wave optics: interference and diffraction. Lectures, problems, and laboratory. I; ½ to 1 unit. Prerequisite: General physics and calculus.

372. **Light.** Continuation of Physics 371. Electromagnetic character of light, Maxwell's equations, theory of reflection and refraction, polarization, double refraction, crystal optics, dispersion, scattering, optical properties of metals. II; ½ unit. Prerequisite: Physics 371.

374. **Light Laboratory.** To accompany Physics 372 and continue laboratory work of Physics 371. In addition to experiments related to topics of Physics 372, there are available a number of experiments in spectroscopic techniques and analysis. These include studies of the properties of photographic plates, chemical spectroscopic analysis, analysis of atomic and molecular spectra, Zeeman effect, Raman and fluorescence spectra. II; ½ unit. Prerequisite: Registration in Physics 372 or consent of instructor.

381. **Atomic Physics.** Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. The topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. I, II; 1 unit. Prerequisite: General physics and calculus.

382. **Nuclear Physics.** A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. II; 1 unit. Prerequisite: Physics 381 or 383.

383. **Atomic and Solid State Physics for Engineers.** Lectures and problems. This course introduces the student to basic concepts necessary to the understanding of many modern developments in engineering. Topics covered include basis for the atomic theory of matter, introduction to quantum mechanics, atomic structure, chemical bonds and molecules, theory of the electrical and magnetic properties of solids, imperfections in crystals, semiconductors, thermionic emission and related topics. I, II; ¾ to 1 unit. Prerequisite: General physics; general chemistry, Mathematics 345 or equivalent.

385. **Introduction to Quantum Mechanics.** Experimental foundation; basic postulates; Schrödinger wave equation; hydrogen atom; superposition of states; the calculation of energy, position, momentum and angular momentum; steady state perturbation theory; identical particles, time-dependent perturbation theory; introduction to Dirac theory. The course emphasizes basic principles, applied to simple examples, many of them one-dimensional. Numerical methods for the solution of eigenvalue problems are taught, and used extensively. Recommended to physics majors and also to students in other physical sciences and engineering. Quantum mechanics has become essential for an understanding of atoms, molecules, solids, and chemical and nuclear reactions. I or II; 1 unit. Prerequisite: Elementary physics, Mathematics 343, Mathematics 345, or consent of instructor.

PHYSIOLOGY

(Including Biophysics)

Graduate work in physiology is offered leading to the degrees of Master of Science and Doctor of Philosophy. Admission of beginning graduate students requires a grade-point average no lower than 3.5. There is no departmental requirement of specific undergraduate major or minor fields, but graduate students whose background is deficient in chemistry, physics, biological sciences, or mathematics must rectify these deficiencies early in their graduate careers.

Degree of Master of Science. To obtain the degree of Master of Science, the student must offer at least eight units of acceptable course work in physiology and related subjects. Ordinarily, the program includes Physiology 306 and 307, Advanced Mammalian Physiology; 361, Comparative Physiology; and 362, Cellular Physiology. During the semester when the candidate wishes to obtain the degree, he is examined in writing and orally by a departmental committee. The results of this general examination are taken into consideration by the committee in deciding whether or not he is certified for the degree, and whether or not he is accepted into the doctoral program of the Department of Physiology. No more than one unit of Physiology 481, Individual Topics, can be applied toward a master's degree; students offering Physiology 481 are expected to submit a term paper or brief research report to the adviser and the examining committee. Two units of Physiology 499, Thesis Research, and a thesis may be substituted for two units of course work.

Degree of Doctor of Philosophy. A student whose master's degree was obtained in the department is judged by his past record and by the results of the required written and oral examination. Transfer students whose master's degrees were obtained elsewhere are examined orally and in writing by the graduate committee toward the end of the first year of residence, and the results of this general examination determine in part whether or not they may continue toward the doctorate in this department. In their cases, this examination also determines what transfer credit is allowed toward the doctoral requirements for work completed elsewhere.

The department requires that the candidate pass a written comprehensive examination covering important areas of physiology before he is permitted to take his oral preliminary examination. Six papers are required: one each in general mammalian physiology, comparative physiology, and cellular physiology; one on his minor area; one on philosophy of science, history of biology, and biostatistics; and one on current physiological concepts related to his special area.

Each candidate must take, either as an undergraduate or a graduate student, the following courses or their equivalents: Physiology 306 and 307, Advanced

Mammalian Physiology; 361, Comparative Physiology; 362, Cellular Physiology; 490, the department's introductory graduate course; Chemistry 340, Elementary Physical Chemistry; 350 and 355, General Biochemistry; Zoology 333, Vertebrate Embryology; 334, Vertebrate Histology; 351, Genetics.

In addition to satisfying the department's basic requirements for all students, each candidate specializes by following a program in one of the following areas: mammalian physiology, comparative physiology, cellular physiology, biophysics, endocrinology, neurophysiology, human anatomy and human physiology, bioclimatology, or radiobiology. An intra-departmental minor may be offered in most of these permissible areas of specialization, chosen from sequences other than Physiology 306, 307, 361, and 362. Details of the various specialized programs can be obtained at the departmental office, 401 Natural History Building.

Minors. Graduate students majoring in other departments who wish to obtain a minor in physiology should see the head of the Physiology Department as early as possible in their graduate studies for discussion of a program and assignment of a departmental minor adviser. For a sole minor, a candidate from another department must offer four courses. For a first minor, three courses are required, two of which must include laboratory work. For a second or split minor, two laboratory courses are required. Courses recommended depend upon the needs of the individual student; usually, a sequence of courses within one area of physiology is desirable. Possible areas for sole and first minors are: cellular physiology (including radiobiology, electrobiology, and biophysics) comparative physiology, mammalian physiology, human anatomy and human physiology, endocrinology, neurophysiology, and bioclimatology.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in physiology may be obtained from the head of the department, 401 Natural History Building.

GRADUATE TEACHING FACULTY

Professors: R. E. Johnson (Head of Department), C. L. Prosser, F. R. Steggerda, A. B. Taylor, H. I. Teigler, G. J. Thomas.
Associate Professors: J. D. Anderson, W. P. Elhardt, F. Sargent, II.
Assistant Professors: H. S. Ducoff, W. H. Johnson, S. G. Stolpe, D. C. Sutfin.

COURSES FOR GRADUATES

401. **Mammalian Physiology Seminar.** Current trends in mammalian physiology. I or II; ½ unit. Prerequisite: Two semesters of mammalian physiology or equivalent; consent of instructor. Steggerda.

403. **Experimental Mammalian Physiology, I.** The physiological applications of experimental mammalian surgery. I, II; 1 unit. Prerequisite: Two semesters of advanced mammalian physiology or equivalent; consent of instructor. Steggerda.

404. **Experimental Mammalian Physiology, II.** The physiological applications of experimental pharmacodynamics. I or II; 1 unit. Prerequisite: Physiology 306 and 307, or equivalent; consent of instructor. Steggerda.

416. **Structure and Function of the Nervous System.** The understanding of nervous function through the experimental approach. II; 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. W. H. Johnson, Thomas.

421. **Gross Human Anatomy.** A general survey of the structures of the human body, with emphasis on the relations between form and function. I or II;

1 unit. Prerequisite: One semester of embryology; consent of instructor. ELHARDT, STOLPE.

441. **Fundamentals of Bioclimatology.** Same as Geography 441. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological and pathophysiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. I or II; ¾ unit. Prerequisite: Consent of instructor. PAGE, SARGENT.

442. **Experimental Bioclimatology.** Same as Geography 442. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. I or II; ½ unit. Prerequisite: Physiology 306 and 307; credit or registration in Physiology 441. PAGE, SARGENT.

443. **Advanced Human Bioclimatology.** Same as Geography 443. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. I or II; ½ unit. Prerequisite: Physiology 441. PAGE, SARGENT.

450. **Human Pathologic Physiology.** Disturbances of function in tissues and organs, and their relationship to the pathogenesis of human disease. I or II; ¾ unit. Prerequisite: Physiology 306 and 307; Chemistry 350 and 355; consent of instructor. R. E. JOHNSON, TEIGLER.

451. **Human Pathologic Physiology Laboratory.** Laboratory methods for measuring the function of organs in the human. I or II; ½ unit. Prerequisite: Credit or registration in Physiology 450; consent of instructor. R. E. JOHNSON, TEIGLER.

452. **Human Physiology Seminar.** Topics of current emphasis in human physiology. I or II; ½ unit. Prerequisite: Physiology 306 and 307; Chemistry 350 and 355; consent of instructor. R. E. JOHNSON, TEIGLER.

462. **Advanced General Physiology.** Same as Zoology 462. Seminar, lectures, student reports, discussions. I or II; ½ unit. Prerequisite: Consent of instructor. PROSSER.

470. **Advanced Cellular Physiology.** The functional organization of macromolecular systems in living cells, with emphasis on experimental techniques. I or II; 1 unit. Prerequisite: One year of general physics, calculus, and physical chemistry; Physiology 362. W. H. JOHNSON.

481. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. Not more than one unit in Physiology 481 may be offered toward a master's degree. I, II; ½ to 1 unit. Prerequisite: Approval of department. STAFF.

490. **Areas and Concepts of Physiology.** The general concepts and methodology of physiology in its various special fields. Required of all graduate majors in physiology during their first year of residence. I or II; ¼ unit. Prerequisite: Graduate major in physiology. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.
Research may be conducted in the following areas, with the consent of the instructor:

(a) **Cellular Physiology, Biophysics, Electrobiology, and Radiobiology.** ANDERSON, DUCOFF, W. H. JOHNSON, PROSSER, TAYLOR.

(b) **Comparative Physiology.** ANDERSON, PROSSER.

(c) **Mammalian Physiology.** STEGGERDA, SUTFIN.

(d) **Human Anatomy and Human Physiology.** ELHARDT, R. E. JOHNSON, STOLPE, TAYLOR.

(e) **Endocrinology.** STOLPE.
(f) **Neurophysiology.** W. H. JOHNSON, THOMAS.
(g) **Bioclimatology.** SARGENT.
(h) **Environmental and Stress Physiology.** R. E. JOHNSON, SARGENT, STEGGERDA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Advanced Mammalian Physiology.** The significance of muscle, nerve, blood, and circulation in mammalian physiology. I; 1 unit. Prerequisite: Courses totaling twenty hours in chemistry, animal biology, or both, beyond the introductory freshman courses; consent of instructor. STEGGERDA, SUTFIN.

307. **Advanced Mammalian Physiology.** The significance of respiration, digestion, metabolism, excretion, temperature regulation, and hormones in mammalian physiology. II; 1 unit. Prerequisite: Courses totaling twenty hours in chemistry, animal biology, or both, beyond the introductory freshman courses; consent of instructor. STEGGERDA, SUTFIN.

331. **General Radiobiology.** Response of multicellular organisms, cells, and macromolecules to ionizing radiations. Lectures, student reports, and discussions. I; 1 unit. Prerequisite: One year each of mathematics, physics, chemistry, and biology. DUCOFF.

361. **Comparative Physiology.** Same as Zoology 361. A comparison of the general physiology of different groups of animals. I; 1 unit. Prerequisite: Three semesters of animal biology; two semesters of chemistry. ANDERSON, PROSSER.

362. **Cellular Physiology.** Same as Zoology 362. A physico-chemical analysis of biological functions common to most living cells. II; 1 unit. Prerequisite: Two semesters each of biology and general physics; three semesters of chemistry. ANDERSON, W. H. JOHNSON, PROSSER.

363. **Endocrinology.** Same as Zoology 363. The glands of internal secretion with special reference to the vertebrates. I annually; II in 1958-1959 and in alternate years; 1 unit. Prerequisite: One semester of elementary zoology or physiology; Zoology 334 or organic chemistry. HALL.

Biophysics

The Biophysical Division of the Department of Physiology offers a curriculum leading to the degree of Doctor of Philosophy in Biophysics. The degree of Master of Science in Biophysics may be granted upon individual petition in special cases. The objective of the curriculum is to give the student sufficient training in physics, chemistry, and biology to enable him to use the conceptual, instrumental, and mathematical approach of the physical scientist in the solution of biological problems.

The curriculum is administered by a divisional committee consisting of faculty members from several departments, who have an active interest in biophysics. Research areas represented in this group include bioacoustics, cellular physiology, electrobiology, microbiology, molecular biology, physics of muscular contraction, photobiology (photosynthesis and related topics), and radiobiology. Students entering the curriculum may elect to do research in any of these areas. Those desiring further information should write to the Executive Secretary, Biophysical Division, Department of Physiology.

Admission. Admission requirements are one year of college biology, one year of college physics, quantitative analysis (five hours), organic chemistry (five hours), and calculus (six hours). Applicants must have a grade-point average of at least 3.75. Students with deficiencies in entrance requirements can be admitted upon approval of the Committee, but these deficiencies must be remedied as soon

as possible in the course of graduate study, and no graduate credit is granted for this work.

Course Requirements. The curriculum is designed for two types of students, with undergraduate training predominantly in the physical sciences or predominantly in the biological sciences.

Students entering from undergraduate study of *physical sciences* may not always be able to meet the entrance requirements in biology; the rectification of these deficiencies in the first year of graduate study is required, because graduate courses in biology can not be taken profitably without proper background in general biology. Courses taken in an area of biology to rectify such deficiencies must be equivalent to courses acceptable for undergraduate majors in that area. On the other hand, students in this group can be expected to have taken, in their undergraduate study, not only all the courses in physical sciences required for entrance, but also most or all of the physics and chemistry courses listed below as mininum requirements for graduate study. In addition to the minimum requirements listed below, these students must take at least two additional units of study in advanced physics or chemistry, or both.

Students entering the curriculum from undergraduate study of *biological sciences* can be expected to have completed all entrance requirements in biology, but may have deficiencies in the requirements in physical sciences and mathematics. These requirements must be satisfied if possible in the first year of graduate study, since they constitute prerequisites for admission to advanced courses in physical sciences which students of this group have to take. Courses taken to rectify deficiencies must be equivalent to courses acceptable for undergraduate students majoring in physics. In order to obtain an understanding of the analytical methods and of the theoretical and experimental approach needed for biophysical work, these students are required to obtain before or during their graduate careers a knowledge of theoretical mechanics, electricity and magnetism, and atomic and molecular physics, as well as of physical chemistry. The courses listed below constitute minimal requirements in these areas, and students are urged, if at all possible, to take additional courses in advanced chemistry and physics.

General Course Requirements. Before taking the preliminary examination, admitting to Ph.D. candidacy, all students are required to take the following courses, or show equivalent credits.

(1) Mathematics, Physics, and Chemistry: Mathematics 343, Advanced Calculus, or Mathematics 345, Differential Equations and Orthogonal Functions; Physics 321, Theoretical Mechanics; Physics 341 and 342, Electricity and Magnetism; Physics 381, Atomic Physics; Chemistry 342, 343, 344, 345, Physical Chemistry (a one-year sequence including lectures and laboratory); Chemistry 350 and 355, Biochemistry. Certain of the required physics courses can be waived, upon approval of the Committee, in cases where the student has had comparable training in advanced courses in physical chemistry. A knowledge of colloidal and macromolecular phenomena equivalent to one semester of work comparable to Chemistry 346 is deemed necessary for work in biophysics.

(2) Biology: Zoology 351, Genetics, or Botany 322, Genetics; three units of graduate course work in one of the major areas of biology, determined by the research interests of the student. This last requirement is designed to acquaint the student with the problems confronting investigators in a selected area of biology, and courses should be chosen accordingly. The course in genetics can be included as part of the three-unit requirement in biology.

(3) Biophysics: Biophysics 401, The Biophysics of the Cell, or equivalent; Biophysics 402, Advanced Biophysics; Biophysics 403, Biophysical Techniques; one additional course in biophysics (other than research).

Other Requirements. The general Graduate College requirements listed

earlier in this bulletin must be met by the student. The above described biophysics curriculum meets the requirements of the Graduate College with regard to major and minor subjects. Students entering from the biological sciences may, for example, declare a minor in physics or chemistry, or a minor in both, utilizing required courses in these fields, while students entering from the physical sciences may declare a sole minor in a selected field of biology. Other minors are possible but must meet Graduate College requirements and the approval of the Committee.

Minor. Subject to the approval of the Committee, candidates for the degree of Doctor of Philosophy in other fields may take a minor in biophysics. This minor must meet the general requirements of the Graduate College.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in biophysics may be obtained from the executive secretary of the division.

COURSES FOR GRADUATES

401. **The Biophysics of the Cell.** Topics included are molecular structure of the cell; cell dynamics, including material and energy balance and exchanges; specific functions of cells, such as motility, excitability, secretion, and others; cell duplication. Laboratory work illustrates some of these topics by experiments on appropriate cell types. I; 1 unit. Prerequisite: One year of college physics, calculus, and physical chemistry; consent of instructor. STAFF.

402. **Advanced Biophysics.** Applications of the experimental and theoretical methods of physics to problems of biology, including the actions of electrical currents, electromagnetic radiations, high energy particles and radiations, and acoustical energy on biological systems; physical phenomena in biological materials, including action currents, photosynthesis, bioluminescence, and others. II; ¾ unit. One year of physics beyond introductory physics or equivalent, calculus, physical chemistry. STAFF.

403. **Biophysical Techniques.** This course is designed to acquaint the student with physical methods useful in the solution of biological problems. Topics covered are bioelectric measurements, including basic electronics; optical methods, including microscopy, spectrophotometry, and measurement of action spectra; use of high energy radiations; tracer techniques; acoustical techniques. II; ½ to 1 unit. Prerequisite: Credit or registration in Biophysics 402, or consent of instructor. STAFF.

410. **Special Topics in Biophysics.** An advanced course on some topic of interest in biophysics, such as electrobiology, radiation biology, photobiology, bioacoustics, or the physics of muscular contraction. I; ½ unit. Prerequisite: Biophysics 401 or equivalent; Biophysics 402 and 403.

411. **Seminar.** Survey of the literature in one area of biophysics, with special emphasis on student reports. II; ½ unit. Prerequisite: Enrollment in the biophysics program or consent of instructor.

499. **Research.** Research may be conducted in one of the areas listed below, subject to approval of the staff member concerned and the department in which the research is to be done. I, II; 0 to 4 units.
   (a) **Bioacoustics.**
   (b) **Cellular Physiology.**
   (c) **Electrobiology.**
   (d) **Microbiology.**
   (e) **Biophysics of Macromolecules.**
   (f) **Photosynthesis.**
   (g) **Physics of Muscular Contraction.**
   (h) **Radiobiology.**

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Biophysics.** A review of the field of biophysics designed to introduce the student to the types of biological problems currently under investigation in biophysical laboratories. I; ¼ unit. Prerequisite: Eight hours of physics or enrollment in the graduate biophysics program. STAFF.

PLANT PATHOLOGY

Students may choose a major, joint major, or minor in plant pathology. The following fields are available for specialization in plant pathology: diseases of field crops, forest and shade trees, fruit crops, ornamentals, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science degree must meet the general requirements of the Graduate College and must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination before a committee of five staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy degree must meet the general requirements of the Graduate College regarding foreign languages, special examinations, minors, and theses.

Beginning graduate students are accepted with a grade-point average of 3.75.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in plant pathology may be obtained from the head of the department, 218 Mumford Hall.

GRADUATE TEACHING FACULTY

Professors: W. M. BEVER (Head of Department), L. M. BLACK, J. C. CARTER, D. GOTTLIEB, M. B. LINFORD, M. B. LINN, D. POWELL, H. H. THORNBERRY.

Associate Professor: J. W. GERDEMANN.

Assistant Professors: D. W. CHAMBERLAIN, R. M. ENDO.

COURSES FOR GRADUATES

401. **Diseases of Forest and Shade Trees.** A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. II; ½ to 1 unit. Prerequisite: Plant Pathology 317 or consent of instructor. CARTER.

403. **Physiology of Fungi.** Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Organic or biochemistry; mycology, plant pathology, or microbiology. GOTTLIEB.

404. **Plant Virology.** Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, staining, assay, filtration, and purification; control methods; sources of information; history of virology. I; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Consent of instructor. THORNBERRY.

417. **Discussions in Plant Pathology.** Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. I, II; ¼ unit. STAFF.

424. **Advanced Plant Virology.** Purification and special properties of virus nucleoproteins or selected virus diseases are considered. Different specific topics for concentrated study may be selected for subsequent semesters depending upon the student's interest. A specific topic pertinent to the student's thesis problem may be selected. Theories and original data are to be critically analyzed and evaluated. I; ½ to 1 unit. Offered in 1959-1960. and in alternate years. Prerequisite: Plant Pathology 404 or consent of instructor. THORNBERRY.

499. **Thesis Research.** Research on the thesis problem in plant pathology. I, II; 0 to 4 units. BEVER, BLACK, CARTER, CHAMBERLAIN, ENDO, GERDEMANN, GOTTLIEB, LINFORD, LINN, POWELL, THORNBERRY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** For students desiring to study specific problems not assigned in other courses. I, II; ¼ to 1 unit. Limited to a total of 8 credits or 2 units. STAFF.

307. **Fruit Diseases.** Same as Horticulture 307. Symptomatology; laboratory and field studies of representative diseases; control measures. II; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. POWELL.

308. **Vegetable and Canning Crop Diseases.** Same as Horticulture 308. Symptomatology; laboratory and field studies of representative diseases; control measures. I; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Plant Pathology 317 or Botany 372. LINN.

317. **Plant Pathology.** Same as Botany 317. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science, including Botany 100. BLACK.

Botany 372. General Mycology. Structure, classification, and identification of fungi, including those of economic importance. Modification of the course is made to meet the needs of teachers and prospective teachers during the summer. II; 1 unit. Prerequisite: One year of botany, bacteriology, entomology, or zoology. ROGERS.

377. **Diseases of Field Crops.** Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Plant Pathology 317 or consent of instructor. BEVER.

379. **Research Methods in Plant Pathology.** Techniques for the isolation, identification, culture of and inoculation with plant pathogens; methods for the histological study of diseased plants; recording of data. I; ¾ unit. Prerequisite: Plant Pathology 317. GERDEMANN.

POLITICAL SCIENCE

The Department of Political Science offers graduate work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work is conducted in the following special fields: American government and politics, comparative government and politics, international law and relations, public administration, political theory and jurisprudence. A separate program leading to the degree of

Master of Arts in Public Administration is administered by the department and is described in literature which will be furnished upon request directed to the department, 324 Lincoln Hall.

In order to be admitted to graduate work in political science a student must have a grade-point average of at least 3.75. He must also have had a minimum of twenty hours of undergraduate work in political science, economics, finance, sociology, or history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history). If a student making political science his major is taking both of his minors in other departments, one of them must be in history, economics, or sociology.

Several courses given in other departments are so closely related to those in political science that graduate students whose major is political science may be permitted on petition to take such courses as part of their major work. Attention is called to the courses in public law in the College of Law, the courses in public finance in the College of Commerce and Business Administration, the courses in city and regional planning in the College of Fine and Applied Arts, and the courses in municipal and sanitary engineering in the College of Engineering. An extension curriculum in public administration leading to the Master of Arts degree is offered at Springfield, Illinois. This curriculum is designed particularly as in-service training for persons in the various state services.

Graduate students in other departments who choose political science as a minor must have had at least six hours of undergraduate work in political science and three hours in economics, sociology, or history.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in political science may be obtained from the chairman of the department, 324 Lincoln Hall.

In addition to University fellowships, the following fellowships are available to graduate students in political science: the James Wilford Garner Fellowship, the John A. Fairlie Fellowship, and the Charles E. Merriam Fellowship, each carrying (beginning 1959-1960) a stipend of $1,800. The Department of Political Science participates with the Department of History in the Kendric C. Babcock Fellowship. For the third year, these appointments carry a stipend of $1,800 (beginning 1959-1960), and postdoctoral grants carry a stipend of $2,400.

GRADUATE TEACHING FACULTY

Professors: C. F. Snider (Chairman of Department), R. Dangerfield, C. B. Hagan, V. Jobst, C. M. Kneier, E. G. Lewis, F. G. Wilson.

Associate Professors: J. M. Edelman, G. Manner, P. Monypenny, J. W. Peltason, J. A. Ranney.

Assistant Professors: R. L. Butwell, T. Page, R. E. Scott.

COURSES FOR GRADUATES

400. **Classics of Political Science.** Reading, analysis, and discussion of leading works on politics and government. I or II; 1 unit. Staff.

401. **History of Political Theories.** Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. I; 1 unit. Wilson.

402. **History of Political Theories.** Reading and analysis of the leading political thinkers from the middle of the seventeenth century to the present. II; 1 unit. Wilson.

406. **Municipal Administration.** Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. I or II; 1 unit. Kneier.

410. **Problems in Rural Local Government.** Research in selected topics. I or II; 1 unit. SNIDER.

412. **Problems in State Government.** Research in selected topics in American state government. I or II; 1 unit. SNIDER.

420. **Formation of Public Policy.** Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. I or II; 1 unit. HAGAN.

421. **Government and the Economic Order.** Same as Communications 421. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. I or II; 1 unit. HAGAN.

423. **Politics of Labor Law.** Same as Labor and Industrial Relations 423. Labor's role in politics and as a pressure group; theories of labor policy formation; organization, procedures, and policy development in the administration of labor law; labor policy formation in the courts; labor's role in foreign political systems. I, II; 1 unit. Prerequisite: Consent of instructor. EDELMAN.

426. **Political Parties.** Special problems in political parties; methods and materials of research in this field. I or II; 1 unit. RANNEY.

431. **Problems of British Government.** Special topics relating to British government. I or II; 1 unit. LEWIS.

450. **Contemporary Governmental Problems.** Special problems of current importance. Designed especially for students not majoring in political science. S; 1 unit. STAFF.

451. **Constitutional Law.** Research in selected topics in the American constitutional system. I; 1 unit. Prerequisite: Political Science 351 or equivalent. PELTASON.

465. **Problems in Administrative Management.** An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. I or II; 1 unit. Prerequisite: Political Science 361 or 364, or consent of instructor. MONYPENNY.

466. **Current Administrative Theory.** A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. I or II; 1 unit. MONYPENNY.

471. **Problems in International Organization.** Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. I or II; 1 unit. BUTWELL.

481. **Foreign Relations of the United States.** Special problems in the development and conduct of American foreign policy. I or II; 1 unit. BUTWELL.

485. **International Law.** Research in selected topics. I or II; 1 unit. JOBST.

493. **Research in Selected Topics.** Research in selected topics by arrangement with the instructor. I, II; 1 unit. STAFF.

495. **Scope and Methods of Political Science.** Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of poli-

tics; techniques for selecting research problems, collecting and interpreting data, and reporting results; the present state of research in political science. I or II; 1 unit. MONYPENNY.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Municipal Government.** Growth of cities; their legal status; municipal politics and organization in the United States. I; ½ to 1 unit. KNEIER.

306. **Municipal Problems.** Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. II; ½ to 1 unit. KNEIER.

310. **Rural Local Government.** Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. I or II; ½ to 1 unit. SNIDER.

312. **State Government.** The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; reorganization problems in the state; state-local relations; state finance; trends and prospects. Students may not receive credit for both Political Science 110 and 312. I or II; ½ to 1 unit. SNIDER.

315. **Legislatures and Legislation.** The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reorganization. I or II; ½ to 1 unit. HAGAN.

321. **Government and the Economic Order.** A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. I; ½ to 1 unit. HAGAN.

325. **Political Parties: Historical Development and Issues.** Nature of American party system; historical development of parties and issues; third or minor parties and their role. I or II; ½ to 1 unit. RANNEY.

326. **Political Parties: Organization and Methods.** Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. I or II; ½ to 1 unit. RANNEY.

328. **Political Behavior: The Electoral Process.** A study of the principal characteristics of and influences upon voting behavior in the United States; methods for studying voting behavior and predicting elections; analysis of present alignments in the electorate as revealed by recent elections. I or II; ½ to 1 unit. RANNEY.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. I or II; ½ to 1 unit. LEWIS.

336. **Continental European Governments and Politics.** An analysis of the major political systems of continental Europe; constitutional and legal structures of France, Germany, Italy, the Soviet Union, and Spain; factors in the struggle for power; political and social movements as they affect the European scene; relation of political to economic, religious, and social institutions in Europe. II; ½ to 1 unit. LEWIS.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin-American political institutions; systems of government; public administrative systems; party government; international policies of Latin-American governments. I or II; ½ to 1 unit. SCOTT.

343. **International Relations of Latin America.** Latin-American position and objectives in international affairs, with emphasis on the Latin-American viewpoint; the Monroe Doctrine; the Good Neighbor Policy; the organization of American states and the United Nations; recent relations of specific nations. I or II; ½ to 1 unit. SCOTT.

345. **Theory and Practice of Democratic Government.** Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. I or II; ½ to 1 unit. RANNEY.

346. **Theory and Practice of Communism.** A survey of the international communist movement. The origins of modern communism and the nineteenth century development of its doctrines; the Russian Revolution; Lenin and Stalin; the U.S.S.R. as a model for communism; the regional development of Communist parties. Students do not receive credit for both Political Science 346 and 396. I or II; ½ to 1 unit. WILSON.

351. **American Constitutional System.** Judicial interpretation of the constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. I; ½ to 1 unit. PELTASON.

355. **The Constitution and Civil Liberties.** A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. I or II; ½ to 1 unit. PELTASON.

356. **Administrative Law in the United States.** A study of the powers of administration, of the legal requirements for and the limits on the exercise of such powers, of the internal and external means of safeguarding individual rights, and of the enforcement of the responsibility of administrative officers both politically and legally. II; ½ to 1 unit. MONYPENNY.

359. **Jurisprudence.** Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. I or II; ½ to 1 unit. MANNER.

361. **Introduction to Public Administration.** Development of administrative organizations; administration and the executive, legislative, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. I; ½ to 1 unit. MONYPENNY.

365. **Government and Labor.** Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. I or II; ½ to 1 unit. EDELMAN.

367. **Public Fiscal Administration.** The public budget process in representative governmental units: preparation and control, the budget as a tool of policy, audit functions, supply services, claim settlement, fund and debt management, relation to organization and methods analysis and personnel utilization, and intergovernmental fiscal relations. I or II; ½ to 1 unit. PAGE.

368. **Public Personnel Administration.** Same as Labor and Industrial Relations 368. An analysis of personnel management in government. Recruitment and selection, job and salary classification, work standards, training, and the role

of labor and professional organizations in the public services are considered in the light of current theory and practice. I or II; ½ to 1 unit. PAGE.

371. **International Organization.** General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the League of Nations, the United Nations, and related agencies. I or II; ½ to 1 unit. BUTWELL.

372. **International Organization.** The problem of war and security; pacific settlement of disputes; the functioning of the United Nations and other international agencies in respect to economic and social problems. I or II; ½ to 1 unit. BUTWELL.

381. **American Foreign Relations.** Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty-making power; development of foreign policy. I or II; ½ to 1 unit. BUTWELL.

382. **Contemporary American Foreign Policies.** Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. I or II; ½ to 1 unit. SCOTT.

384. **International Relations.** An examination of the nature of the national state system, of the forces affecting international relations, of the sources of conflicts in international politics, and of their solution by power politics or by international cooperation. I or II; ½ to 1 unit. MANNER.

385. **International Law.** Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. I; ½ to 1 unit. JOBST.

386. **International Law.** Responsibility, intercourse, and redress of differences between states. II; ½ to 1 unit. JOBST.

393. **History of Political Theory.** A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of Christian political thought and the Middle Ages; political theory during the Renaissance, Reformation, and Counter-Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, Utopianism, and socialism. I or II; ½ to 1 unit. WILSON.

396. **Contemporary Political Theory.** Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; anti-democratic thought and totalitarian regimes. Students may not receive credit for both Political Science 396 and 346. I or II; ½ to 1 unit. WILSON.

397. **American Political Theory.** A survey of American political thought from colonial times to the present. I; ½ to 1 unit. Offered in 1959-1960 and in alternate years. WILSON.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Fields. Doctoral programs are offered in the following special areas of psychology: general experimental psychology, personality, social psychology, psychological measurement, clinical and counseling psychology, engineering psychology, industrial psychology, school psychology.

Admission. The candidate must meet the following departmental requirements: (1) a minimum of fifteen semester hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) a one-year course in another laboratory science; (4) a grade-point average of at least 4.0. Preference is given to students who have taken college mathematics and two years of French or German. Because it is necessary to limit admissions to graduate study in psychology, it is not possible to accept all applicants who meet the minimal requirements.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The degree of Master of Arts is awarded to candidates who complete satisfactorily eight units of course work and present an acceptable thesis.

All first-year graduate students in psychology must take Psychology 403, 404, and 406. The doctoral candidate must also take Psychology 407 or the equivalent, and must complete an approved program of courses in his area of specialization.

In the fields of clinical and counseling psychology, engineering psychology, industrial psychology, and school psychology, the doctoral candidate must also complete the equivalent of a full-time academic year of internship or research in an agency approved by the Department of Psychology.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in psychology may be obtained from the head of the department, 314 Gregory Hall.

TRAINEESHIPS

United States Public Health Service Traineeships in Clinical Psychology. All graduate students in this field, including first-year applicants, are automatically considered for these appointments. No application is necessary. Current stipends (tax-free) are: Level I, $1,800; Level II, $2,000; Level III, $2,400; Level IV, $2,800. The trainee has no duties other than full-time graduate work.

Veterans Administration Traineeships in Clinical and in Counseling Psychology. First-year students are not eligible for these appointments. Applicants for advanced standing may apply for a traineeship by a letter addressed to the head of the Department of Psychology. The trainee works approximately half-time in a Veterans Administration hospital as a Civil Service appointee.

GRADUATE TEACHING FACULTY

Professors: L. H. Lanier (Head of Department), R. B. Cattell, T. N. Ewing, W. M. Gilbert, G. R. Grice, L. A. Hellmer, G. D. Higginson, L. G. Humphreys, J. M. Hunt, W. E. Kappauf, O. H. Mowrer, L. I. O'Kelly, C. E. Osgood, P. T. Young.

Associate Professors: J. A. Adams, J. B. Cohen, C. W. Eriksen, F. E. Fiedler, H. W. Hake, Alice K. Jonietz, W. G. McAllister, D. R. Peterson, H. Rosen, I. D. Steiner.

Assistant Professors: W. C. Becker, D. E. Dulany, N. H. Eisen, J. C. Nunnally, D. J. Shoemaker.

COURSES FOR GRADUATES

The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all of the prerequisites.

401. **History of Psychology.** I or II; 1 unit. Prerequisite: Twelve hours of psychology. Grice.

402. **Systematic Psychology.** A critical analysis and comparison of modern and contemporary psychological systems. I or II; 1 unit. Prerequisite: Twelve hours of psychology. LANIER.

403. **Proseminar in General Psychology, I.** A brief historical introduction to modern psychology; fundamentals of differential psychology, including the measurement of intelligence, aptitudes, and personality; motivation, emotion, and mechanisms of defense; psychological development; social behavior. I; 1 unit. Prerequisite: Twelve hours of psychology.

404. **Proseminar in General Psychology, II.** Sensory processes; perception; fundamental processes in learning; learning theory; special aspects of human learning; language behavior; thinking; logical aspects of psychological theory. II; 1 unit. Prerequisite: Twelve hours of psychology.

406. **Quantitative Methods, I.** A lecture and laboratory course in the development and application of quantitative methods in psychological research. I, II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. HAKE, KAPPAUF.

407. **Quantitative Methods, II.** Continuation of Psychology 406. I, II; 1 unit. Prerequisite: Psychology 406. HUMPHREYS, KAPPAUF.

408. **Design of Experiments in Psychology.** Advanced experimental designs in psychological research; special methods of data analysis. I or II; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Psychology 407. KAPPAUF.

409. **Psychological Measurement.** Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. I or II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Six units of graduate credit, including Psychology 407. HUMPHREYS.

411. **Advanced Physiological Psychology.** Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation, learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. O'KELLY.

415. **Experimental Sensory Psychology.** A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. I or II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. KAPPAUF.

416. **Perception.** Systematic study of methods and research findings in the field of human perception, together with an evaluation of theoretical interpretations. I, II; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Twelve hours of psychology. HAKE.

417. **Experimental Psychology of Learning, I: Basic Processes.** A study of experimental investigation of basic learning processes with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. I; 1 unit. Prerequisite: Twelve hours of psychology. GRICE.

418. **Experimental Psychology of Learning, II: Human Learning.** Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. II; 1 unit. Prerequisite: Psychology 417 or consent of instructor. ADAMS.

419. **Advanced Comparative Psychology.** A critical examination of specific techniques used and of representative results obtained in the study of animal behavior. Laboratory demonstrations and individual research problems. I

or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 345 or equivalent. McAllister.

421. **Problems in Motivation.** I or II; 1 unit. Prerequisite: Twelve hours of psychology. Young.

426. **Psycholinguistics.** Same as Communications 426. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. Application is made to various problems in communication and the social sciences. I or II; 1 unit. Prerequisite: Six units of graduate work in psychology or consent of instructor. Osgood.

427. **Engineering Psychology.** Experimental psychology applied to the study of man-machine interrelationships; psychological factors in the design of communication and control equipment. I, II; 1 unit. Prerequisite: A laboratory course in experimental psychology or equivalent. Hake.

431. **Psychological Measurement in Industry.** Application of psychometric methods and the findings of differential psychology to the selection, classification, and performance evaluation of industrial personnel. I or II; 1 unit. Prerequisite: Psychology 407 or equivalent. Humphreys.

435. **Motivation and Morale in Industry.** Same as Labor and Industrial Relations 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. I or II; 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. Rosen.

442. **Behavior Disorders.** A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. II; 1 unit. Prerequisite: Psychology 338 and 403. Peterson.

443. **Psychodiagnostics, I.** Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and achievement. I; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 290 or equivalent. Eriksen.

444. **Psychodiagnostics, II.** Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. II; 1 unit. Prerequisite: Psychology 443; consent of instructor. Eriksen.

445. **Psychodiagnostics and Psychotherapy, I.** Provides didactic training and supervised experience in psychodiagnostics and psychotherapy. Students are required to enroll concurrently in Psychology 463-464, as a means of relating the practicum experience with the study of research methodology. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 442, 443, and 444; consent of instructor. Gilbert, Hellmer, Jonietz, Shoemaker.

446. **Psychodiagnostics and Psychotherapy, II.** Continuation of Psychology 445. II; 1 unit. Prerequisite: Psychology 445; consent of instructor. Gilbert, Hellmer, Jonietz, Shoemaker.

451. **Advanced Social Psychology.** A systematic and critical treatment of individual behavior variables in relation to group variables. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 255 or equivalent. Steiner.

456. **Psychology of Social Communication.** Same as Communications 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup

attitudes through communication. I or II; 1 unit. Prerequisite: Psychology 451 or equivalent, or consent of instructor.

457. **Social Perception and Interpersonal Relations.** The genesis and development of social perception, with emphasis upon the concept of the "self" and its role in social perception; motivational factors in social perception; interpersonal perception, and its effects upon individual and group behavior. I or II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Psychology 451 or equivalent. FIEDLER.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision-making, group cohesiveness, and productivity. I or II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Six units of graduate credit in psychology, including Psychology 451 or equivalent. STEINER.

459. **Leadership and Group Effectiveness.** Theories of leadership; methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. I or II; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Psychology 451 or equivalent. FIEDLER.

461. **Developmental Psychology.** Theory and research on psychological development from birth through adolescence; maturation of behavior systems; the role of social learning in development; the effects of early experience on personality development; critical stages in development. I or II; 1 unit. Prerequisite: Twelve hours of psychology or consent of instructor. HUNT.

462. **Human Abilities.** Analysis of individual differences in human abilities, including historical background, measurement methodology, and functional correlates of abilities. The use of ability measures in both experimental and applied research is considered. Offered in 1959-1960 and in alternate years. I or II; 1 unit. Prerequisite: Psychology 407 or equivalent. HUMPHREYS.

463. **Research Methods in Clinical Psychology and Personality, I.** The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. I; ½ unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 406, 407, 443, and 444. HUNT.

464. **Research Methods in Clinical Psychology and Personality, II.** Continuation of Psychology 463. II; ½ unit. Prerequisite: Psychology 463. HUNT.

465. **Multivariate Analysis in Psychology.** The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multi-dimensional scaling. Offered in 1959-1960 and in alternate years. I or II; 1 unit. Prerequisite: Psychology 406 and 407; consent of instructor. NUNNALLY.

466. **Test Construction.** A laboratory course in the construction and evaluation of psychological tests. I or II; 1 unit. Prerequisite: Psychology 495; Psychology 462 or 467. HUMPHREYS.

467. **Personality Assessment.** Methods and theory in the quantitative assessment of personality; review of research findings and trends. Offered in 1958-1959 and in alternate years. I or II; 1 unit. Prerequisite: Psychology 407 or equivalent. BECKER.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories concerning the learning process, including the work of Hull, Tolman, and Guthrie. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. GRICE.

490. **Individual Research.** For graduate students who wish to conduct research on special problems not included in graduate theses. I, II; ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

493. **Seminar.** Discussion of current topics in their historical setting, with special emphasis on research problems. I, II; ½ to 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. STAFF.

495. **Theory of Measurement.** Same as Education 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. I; 1 unit. Prerequisite: Education 496 or Psychology 407; Education 392 or Psychology 290, or equivalent. CRONBACH, HASTINGS, KAISER.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Physiological Psychology.** A study of the physiological basis of behavior, including sensory processes, motivation, emotion, learning, and intelligence. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology; Physiology 103 or 106, or Zoology 101. O'KELLY.

326. **Motivation and Emotion.** The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology. YOUNG.

330. **Experimental Psychology, I.** A survey of problems, experimental methods, and research findings in the fields of psychophysics, sensory processes, perception, judgment, and thinking. I; ½ to 1 unit. Prerequisite: Psychology 100 or 103; a course in statistics. HAKE.

331. **Experimental Psychology, II.** A survey of problems, experimental methods, and research findings in the fields of motivation, learning, retention, and work. Credit is not allowed for both Psychology 331 and 348. II; ½ to 1 unit. Prerequisite: Psychology 100 or 103; a course in statistics. GRICE.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology. BECKER, PETERSON.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. I or II; ½ to 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. MCALLISTER.

348. **The Psychology of Learning.** A survey of the basic facts and theories of the learning process. Credit is not allowed for both Psychology 331 and 348. I or II; ½ to 1 unit. Prerequisite: Six hours of psychology.

357. **Psychology of Industrial Conflict.** Same as Labor and Industrial Relations 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. I, II; ½ to 1 unit. Prerequisite: Psychology 100 or equivalent; Psychology 245, Economics 240, or Sociology 318. ROSEN.

360. **Modern Viewpoints in Psychology.** A brief survey of early theoretical psychology followed by an examination of contemporary "behavior theory," Gestalt theory, and psychoanalytic theory — as conceptions of man and as approaches to the study of learning, perception, personality, and social behavior. I, II; ½ to 1 unit. Prerequisite: Senior standing; nine hours of psychology with an average grade of B, or consent of instructor. DULANY.

RECREATION

The Department of Recreation offers a program of graduate study leading to the degree of Master of Science in Recreation. This program is centered in training leaders, supervisors, administrators, teachers, and research workers in community recreation, but also offers opportunities for training in the related fields of industrial and institutional recreation and specialization in given program areas of recreation such as sports, music, dramatics, arts and crafts, camping, outdoor education, and the like.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate credit in the natural sciences; and (5) a course in statistics or tests and measurements.

Graduation requirements for this degree are eight units including (1) four units of credit in approved courses to be chosen in the following areas: recreation, education, political science, psychology, social work, and sociology; (2) two units of approved electives to be chosen in the following areas: art, botany, geology, health education, landscape architecture, literature, music, physical education, speech, and zoology; (3) registration in and satisfactory completion of Recreation 490, without credit; (4) presentation of an acceptable thesis in recreation, two units. The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in recreation may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in recreation may be obtained from the head of the department, 111 Huff Gymnasium.

GRADUATE TEACHING FACULTY

Professor: C. K. Brightbill (Head of Department).
Associate Professor: A. V. Sapora.
Assistant Professor: H. E. Weaver.

COURSES FOR GRADUATES

401. **Foundations of Recreation.** Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. I or II; 1 unit. Prerequisite: Recreation 176 or equivalent. Brightbill.

402. **Recreation Administration.** Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. I, II; 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent. Brightbill.

403. **Evaluation of Recreation Resources and Programs.** Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; and research in the

field of recreation. I or II; 1 unit. Prerequisite: Recreation 176 or 275 or equivalent; a course in tests and measurements or statistics. SAPORA.

404. **Outdoor Education and Recreation.** Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. II; 1 unit. Prerequisite: Recreation 174 or equivalent; one undergraduate course in biology, botany, geology, or zoology. WEAVER.

490. **Seminar.** Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. I, II; no credit. STAFF.

493. **Special Projects.** Independent research on special projects. Open only to students majoring in recreation. I, II; ½ to 2 units. Prerequisite: Recreation 403 or equivalent. STAFF.

499. **Thesis Research.** Preparation of theses in recreation. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

375. **Organization of Recreation Programs.** Organization of public and private agency programs, leadership, facilities and services, and introduction to recreation administration. I, II; ½ unit. Prerequisite: Recreation 176. SAPORA.

SOCIAL SCIENCES

Master of Arts in the Social Sciences. A special program leading to the degree of Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including economics, geography, history, philosophy, political science, psychology, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 3.75.

The degree of Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work which are mandatory for the major. At the completion of his studies the student must pass an oral comprehensive examination given by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor J. W. Swain, 325 Lincoln Hall. The general adviser for this degree is Professor Charles B. Hagan, 318 Lincoln Hall.

Master of Arts in the Teaching of Social Studies. Candidates for the degree of Master of Arts in the Teaching of Social Studies must earn four units in social studies, three units in education, and one unit in electives. Requirements are (1) social studies selected from not more than three of the following: economics, geography, history, at least two units; philosophy, political science, sociology, four units; (2) two of the following courses: Education 301, 302, 303, 304, one unit; Education 311 and 312, one unit; and Education 456, one unit. The courses

in social studies and the electives must be selected with the approval of the adviser. The electives may be in the social studies, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the division.

The adviser for candidates for this degree is Professor J. W. Swain, 325 Lincoln Hall.

SOCIAL WORK

The School of Social Work offers two years of graduate professional study leading to the degree of Master of Social Work. Although the basic curriculum of the school is the same for all students, there are opportunities for specialization in case work and group work. Students specializing in group work have their classes on the campus of the Professional Colleges in Chicago and field placements in group work agencies in the city. Those specializing in case work may have classes on either the Urbana or Chicago campus, with field placements in selected agencies nearby.

The school has established an admissions committee which is responsible for reviewing all applications. The committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and pre-professional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. Although no specific undergraduate grade-point average is specified, the applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Preference is given to applicants between the ages of twenty-one and thirty-five, but consideration is given to older applicants who have demonstrated their capacity for social work practice. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthy relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

Because of the limited number of field work placements in acceptable social agencies, the school is compelled to limit its enrollment to the number of field work placements available.

Application must be made to the School of Social Work. The special bulletin issued by the school may be obtained by writing to the Director, School of Social Work, 1204 West Oregon Street.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in social work may be obtained from the director of the school, 1204 West Oregon Street.

In addition to University fellowships, traineeships are available from the federal government and scholarships from state governments and from private organizations. The amounts and conditions vary, with some requiring employment commitment after graduation.

GRADUATE TEACHING FACULTY

Professors: Marietta Stevenson (Director of the School of Social Work), Florence L. Poole, W. P. Simon.

Associate Professors: Jennette Gruener, Margaret Holden, D. E. Lathrope, Helen Rabichow, D. Katharine Rogers, W. Schwartz, D. E. Tanenbaum.

Assistant Professors: J. E. McDonald, Mary E. Reese.

COURSES FOR GRADUATES

421. **Social Work Methods, I.** A course in the principles and practice of social work integrating classroom and field instruction. Sections A1 and A2 are required of all students. In addition, sections B1 and B2 are required of case work majors and sections C1 and C2 of group work majors. I; 2 to 4 units.

A1. Community Organization. Study of the community organization process at the neighborhood, city, state, and federal levels with special emphasis on social work method in planning, coordinating, and helping the community to use health, welfare, and leisure-time services. One hour weekly.

A2. Research. Introduction to objectives and methods of research in social work. Basic principles in designing studies, construction of schedules, analysis and presentation of data, and formulation of conclusions. Use and interpretation of descriptive and inductive statistics. One hour weekly.

B1. Social Case Work. Consideration of the principles of social work in the practice of social case work. Through discussion of case material from various settings and from his own field experiences, the student is helped to understand social case work process and to use this in helping the client. Two hours weekly.

B2. Field Instruction in Social Case Work. The student is assigned to a social agency in which he has responsibility for carrying selected cases under the supervision of a qualified field instructor. Instruction is based on the student's own practice and is designed to help him develop skill in social case work. Two days weekly.

C1. Social Group Work. Consideration of the principles of social work in the practice of social group work. Dynamics of the group process and the meaning of program activities. The student is helped to use this understanding to enable the individual and the group to develop a capacity for creative relationships. Two hours weekly.

C2. Field Instruction in Social Group Work. The student is assigned to a social agency in which he has responsibility for direct work with selected groups under the supervision of a qualified field instructor. Instruction is based on the student's own practice and is designed to help him develop skills in social group work. This section includes a weekly two-hour field work seminar with emphasis on understanding and using program content within the group. Two days weekly.

422. **Social Work Methods, II.** More extensive analysis and application of the principles of case work and group work. Sections A1 and A2 are required of all students. In addition, sections B1 and B2 are required of case work majors and sections C1 and C2 of group work majors. II; 2 to 4 units. Prerequisite: Social Work 421.

A1. Social Work Practice. Designed to help the group work student acquire skill in work with individuals in group work settings and the case work student understand and participate in the group process. One hour weekly.

A2. Research. Continuation of Social Work 421, section A2. One hour weekly.

B1. Social Case Work. Continuation of Social Work 421, section B1. Designed to help the student increase his knowledge and improve his skill in the practice of social case work. Two hours weekly.

B2. Field Instruction in Social Case Work. Continuation of the first semester of field instruction. Two days weekly.

C1. Social Group Work. Continuation of Social Work 421, section C2. Designed to help the student increase his knowledge and improve his skill in the practice of social group work. Two hours weekly.

C2. Field Instruction in Social Group Work. Continuation of the first semester of field instruction. Two days weekly.

423. **Social Work Methods, III.** This second-year course includes further emphasis on the student's understanding and skill in social work with broader consideration of practice in various settings. Section A1 is required of all students. In addition, sections B1 and B2 are required of case work majors and sections C1 and C2 of group work majors. I; 2 to 4 units. Prerequisite: Social Work 422.

A1. Social Work Practice. Social work method in different settings. Ways of determining the nature and content of social work services in various settings, and methods of developing collaborative working relationships with other disciplines in the setting. Consideration of some of the content specific to various kinds of agencies in which social work is practiced. One hour weekly.

B1. Social Case Work. Designed to broaden and deepen the student's understanding of social case work and to help him increase his skill in practice. Consideration of both brief and continuing case work service and the use of case work practice in its relation to services of other disciplines. Case material from various settings is examined. Two hours weekly.

B2. Field Instruction in Social Case Work. Based on the student's own practice in the setting that relates to his field of concentration. Three days weekly.

C. Social Group Work. Use of the social group work method is studied with particular attention to the social group work process as related to variations in type, size, and purpose of group. Advanced material in using program content with the group and to the role of the group worker in planning intra-agency service. Two hours weekly.

C2. Field Instruction in Social Group Work. The student's assignment includes more complex group problems and elementary administrative and supervisory responsibilities. Emphasis on enhancing the student's skill in practice as represented in relationship of group achievement to agency purpose, agency program planning, and supervision of group leaders. Three days weekly.

424. **Social Work Methods, IV.** A continuation of Social Work Methods III with the addition of specific material on methods of supervision and administration in social work. Section A1 is required of all students. In addition, sections B1 and B2 are required of case work majors and sections C1 and C2 of group work majors. II; 2 to 4 units. Prerequisite: Social Work 423.

A1. Social Work Practice. Deals with the social worker's practice in areas of supervision, consultation, and administration. Emphasis for the case work student on orientation to the worker's role in consultation, supervision, policy making, and agency program planning. Emphasis for the group work student on supervisory and administrative practice with special reference to supervision of volunteer leaders. One hour weekly.

B1. Social Case Work. Continuation of Social Work 423, section B1. The student is helped to the attainment of more responsibility in case work practice and continued professional growth. Two hours weekly.

B2. Field Instruction in Social Case Work. Continuation of the third semester of field instruction. Three days weekly.

C1. Social Group Work. Further discussion of principles and practice in social group work with emphasis on the student's ability to present, analyze, and evaluate material from his own practice. Two hours weekly.

C2. Field Instruction in Social Group Work. Continuation of the third semester of field instruction. Three days weekly.

451. **Dynamics of Human Development, I.** This course is designed to increase the student's understanding of the physical, emotional, intellectual, and social development of the individual throughout the life cycle. Relevant material from the fields of medicine, psychiatry, psychology, and anthropology is included. Emphasis is placed on the individual's behavior as an interaction of physical and psychological factors with the social environment. Four hours weekly. I; 1 to 2 units.

453. **Dynamics of Human Development, III.** Information concerning the normal physiological functioning of the body and the breakdown of such function resulting in major and chronic diseases. Interrelationship of physical and emotional aspects of causation and management of the disease. Consideration of physiological, psychological, and social factors influencing diseases and use of resources provided by the community for medical treatment. Three hours weekly. I; 1 to 2 units. Prerequisite: Social Work 451.

454. **Dynamics of Human Development, IV.** Information concerning the dynamics of neuroses and psychoses and social implications of these disorders. Emphasis on the emotional reactions manifested as a result of the individual's attempt to maintain a functioning balance. Consideration of social, psychological, and physiological factors influencing disorders and the use of resources provided by the community for treatment. Three hours weekly. II; 1 to 2 units. Prerequisite: Social Work 451.

461. **Special Studies in Social Work, I.** Independent or group study in areas of special interest, application of social work principles to special problems or settings. I, II; 1 to 2 units.

462. **Special Studies in Social Work, II.** Independent or group study in areas of special interest, application of social work principles to special problems or settings. I, II; 1 to 2 units.

481. **Social Welfare Organization, I.** Deals with the development of services and organization for social welfare with emphasis on the political, social, and economic forces giving rise to their growth in the English and early American experiences. Consideration of the emerging specialized services, the contribution of private philanthropy, and the expansion of public responsibility. Three hours weekly. I; 1 to 2 units.

482. **Social Welfare Organization, II.** Principles and content of public and private programs directly affecting family welfare, particularly income maintenance and related services. Consideration of the social insurances, public assistance, employment services, labor standards, protective legislation, and community sponsored family service programs. The focus is on basic premises, content and objectives of each program, the manner of providing minimum protection against economic want, and the maintenance and restoration of the social functioning of individuals and families. Three hours weekly. II; 1 to 2 units. Prerequisite: Social Work 481.

483. **Social Welfare Organization, III.** Development, interrelations, unmet needs and proposals to strengthen programs and services in each of the national, state, and community social welfare programs studied. Consideration of public health, medical care, health insurance, chronic illness and disability,

rehabilitation services, and mental health care. Community services for children including the programs and problems relating to children who are dependent, handicapped, disturbed, or who come in conflict with the law, correctional services, informal educational and leisure-time services and programs for the aging are examined. Three hours weekly. I; 1 to 2 units. Prerequisite: Social Work 482.

484. **Social Welfare Organization, IV.** Analysis of organizational patterns and of the administrative process. Study of the structures of international, national, state, and local public and private agencies to reveal their functions and interrelationships. Review of the administrative process through examination of policy formulation, the executive function, organization, coordination, field services, personnel, budgeting, and public relations. Social action and the legislative process, and current developments and issues in the area of social work are examined. Three hours weekly. II; 1 to 2 units. Prerequisite: Social Work 483.

491. **Research Seminar.** A seminar for students working on research projects, providing experience in the application of research methods to current social welfare problems. Students usually work on group projects, but provision is also made for an individual project. I, II; 0 to 2 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Introduction to Social Case Work.** This course deals with the behavior and attitudes expressed by persons asking for assistance, the feelings thus engendered, and the effects of all of these on the contacts of social case workers with individuals and families. Attention is given to case records selected from social case work practice in public assistance and other community agencies. I, II; ½ unit. McDonald.

316. **Social Services for Children.** This course is designed to acquaint students with the unmet needs of children and the organization of social services to meet those needs. Responsibilities of voluntary as well as public agencies are considered. A survey is made of agencies providing leadership and standard setting in social services for children. I, II; ½ to 1 unit. Prerequisite: Consent of instructor. Rogers.

333. **Introduction to Social Group Work.** This course is designed to present background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustrations from the field of practice in informal education, recreation, and social group work. I; ½ unit. Prerequisite: Introductory courses in sociology, psychology, social sciences. Rogers.

SOCIOLOGY AND ANTHROPOLOGY

The Department of Sociology and Anthropology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy in Sociology and in Anthropology.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in sociology and anthropology may be obtained from the chairman of the department, 320 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: J. E. Hulett, Jr. (Chairman of Department), J. W. Albig, R. Dewey, O. Lewis, D. E. Lindstrom, J. C. McGregor, J. H. Steward.

Associate Professors: E. A. Ahrens, Margaret K. Chandler, C. L. Folse, D. Glaser, A. W. Gouldner, R. W. Janes, E. H. Shideler, B. F. Timmons, E. H. Winter.

Assistant Professors: R. W. England, Jr., J. R. Gusfield, B. Karsh.

Sociology

The basic program of graduate study for all students taking sociology as a major subject consists of a collection of courses designed primarily to give the student a broad training in the principles and in the fundamentals of theory, scientific methodology, and research techniques in the general field of sociology. All students are required to take courses in these areas selected in consultation with the adviser. In addition to the basic program, the department offers opportunities for students to specialize in any one of several fields within the discipline, including rural sociology. Specialized training to meet the particular needs of each student may be arranged through the selection of appropriate courses with the aid of the adviser, through supervised individual work on special topics, and through the research performed in connection with the preparation of the dissertation.

A student intending to offer sociology as a minor in connection with a major in some other field must have had at least six hours of undergraduate work in sociology, and should consult with the chairman of the department before registering for courses.

In order to be considered for admission, students intending to elect sociology as their major must have a grade-point average of 3.5 and must meet the following requirements: (1) a minimum of nine semester hours of undergraduate work in sociology; (2) a course in sociological research methods (Sociology 385 or equivalent); (3) fifteen semester hours of undergraduate work in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Students who can not meet these requirements may register for graduate courses but must remove any deficiencies during the first year of residence by taking without credit such courses as may be prescribed by the adviser. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

Degree of Master of Arts. The requirements for the degree of Master of Arts in Sociology are as follows: (1) Satisfactory completion of a program of eight units of work approved by the adviser. This program must include Sociology 400, a course in research methods, and one unit of thesis credit. (2) Passing the master's written examination designed to test the student's preparation in sociological theory and methods of research and his familiarity with other branches of sociology. (3) Preparation of an acceptable thesis which embodies the results of an original research project. The thesis work is supervised by an advisory committee consisting of the adviser and two other faculty members. After the thesis is completed, the candidate takes an oral examination, primarily on the thesis, conducted by the advisory committee.

Degree of Doctor of Philosophy. A student who has earned the master's degree in sociology, or its equivalent, and who desires to continue toward the doctorate is permitted to do so unless the graduate faculty of the department deems it inadvisable. The student who is granted permission to continue should

consult with his adviser for assistance in the selection of a program of study, which must include an adequate amount of work in sociological theory, scientific method in sociology, and research techniques. The program should be arranged partly with a view toward gaining preparation for the preliminary examination. However, formal course work alone does not provide adequate preparation for the examination. It must be supplemented by an intensive program of individual study and reading selected under the guidance of the adviser.

Candidates for admission to the preliminary examination must be prepared to be examined in five sub-fields of sociology and in the minor subject or subjects. The fields of sociology covered by the examination are: (1) history of sociology and general systematic sociology; (2) individual and the group and collective behavior; (3) community analysis, ecology, and demography; (4) social organization, disorganization, and social process; and (5) sociological methodology and research methods. Information regarding the specific topics included in these fields may be obtained from the adviser.

Upon the recommendation of his adviser, and after he has complied with the relevant regulations of the Graduate College, the student may apply in writing to the executive committee of the department for admission to the preliminary examination, which is given at irregular intervals determined by the needs of the department. The examination consists of a written examination of twenty to twenty-five hours distributed over five days, and a two-hour oral examination. In accordance with the regulations of the Graduate College, the student must be prepared to announce the tentative topic of his proposed doctoral dissertation at the time of the oral portion of the preliminary examination. He should also be prepared to answer questions regarding the topic and the plan for the research.

COURSES FOR GRADUATES

400. General Sociology. Systematic sociology, with emphasis on the development and problems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. I; 1 unit. GOULDNER.

407. Topical Seminar in Rural Sociology. Same as Rural Sociology 407. Analysis of topics of special interest such as population, migration, rural cultural change, rural culture and personality development, rural regions, and comparative rural societies. I; 1 unit. Prerequisite: Twelve hours of social science or introductory statistics, or consent of instructor. STAFF.

412. Seminar in Social and Cultural Relations of Personality. Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. I, II; 1 unit. HULETT.

414. Social Situation and the Social Act. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. I or II; 1 unit. Prerequisite: One unit of graduate credit in sociology. HULETT.

418. Seminar in Industrial Sociology. Same as Labor and Industrial Relations 418. Individual research in sociological interpretation of industrial organization; the orientation and motivation of the individual in industry and commerce; labor-management relations as group adjustments; the interrelations of industry and the community. I or II; 1 unit. Prerequisite: Six hours of sociology including Sociology 318, or consent of instructor. CHANDLER, KARSH.

420. **Seminar in Education for Marriage and the Family.** Review of pertinent recent literature including critical analysis of college and secondary school texts; individually assigned research projects. Emphasis is on teacher-leader preparation. I or II; 1 unit. Prerequisite: Sociology 220 recommended. TIMMONS.

421. **Seminar on Research in Marriage and Family Life.** Analysis of relationships between research methodology and conceptual schemes employed to study family life; critical examination of typical studies which illustrate alternatives in the conceptualization of family interaction and the nature of the family unit. I, II; 1 unit. Prerequisite: Consent of instructor. FARBER.

422. **Theory of Social Groups.** A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations relevant to the solution of empirical problems in group analysis. I or II; 1 unit. GLASER.

424. **Seminar in Penology.** Sociological analysis of law enforcement, adjudication, and the rehabilitation of criminals, with emphasis on direct contact with agencies having these functions, and the design of research projects relevant to their problems. I or II; 1 unit. Prerequisite: Sociology 331 or equivalent. ENGLAND, GLASER.

425. **Racial and Cultural Minorities.** A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. I or II; 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology. GLASER.

431. **Seminar in Criminology.** Analysis of selected research problems on the development of criminological thought and the investigation of the causes of crime. I or II; 1 unit. Prerequisite: Sociology 331 or equivalent. ENGLAND, GLASER.

432. **Critique of Research in Juvenile Delinquency.** Analysis of major investigations into the causes, treatment, and prevention of delinquency and criminality in youth. I or II; 1 unit. Prerequisite: Sociology 331 or consent of instructor; Sociology 431 is recommended. ENGLAND, GLASER.

435. **Field Instruction and Research in Penal Sociology.** Problems of designing and conducting criminological research in penal institutions; supervised training and practice in the functions of sociologists in prisons. Conducted only in the summer with the first and eighth weeks spent on campus; six weeks are spent in the offices of sociologists in prisons. Application for admission to this course must be made in April prior to the summer session in which enrollment is desired. S; 1 unit. Prerequisite: Sociology 324 and 331 or equivalent; consent of instructor; passing routine employment clearance procedures (including fingerprinting) required by the prison. ENGLAND, GLASER.

444. **Seminar in Public Opinion.** Same as Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. I, II; 1 unit. ALBIG.

446. **Opinion Polling Analysis.** Same as Communications 446. The study of current polling practices, organizations, and findings. Evaluation of results in terms of the prediction and interpretation of social behavior. I, II; 1 unit. ALBIG.

447. **Sociology of International Conflict.** I or II; 1 unit.

471. **Regionalism and Social Morphology.** Specific analysis of the problems which apply to regional bases and not to the conventional political boundaries. I or II; 1 unit.

473. **The Community in Modern American Society.** Comparative analysis of community life as it is influenced by institutional trends of the larger society. I or II; 1 unit. Prerequisite: Sociology 400. JANES.

476. **Urban Communities and Urbanization.** Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. I or II; 1 unit.

477. **Rural Communities.** Same as Rural Sociology 477. A study of rural community structure, functions, and processes, to give the student a concrete picture of how rural communities operate, and the forces which cause change in the group life of the people living in a rural community. Field trip; estimated expense, $5.00. I or II; 1 unit. LINDSTROM.

480. **Sociological Theory and Method.** This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. I or II; 1 unit. GOULDNER.

481. **Seminar in Culture Integration.** I or II; 1 unit. LEWIS.

482. **Recent Developments in Sociology.** Intensive study of selected topics based on contemporary works of major importance in the development of sociological theory. II; 1 unit. Students may reregister for a total of two units credit. ALBIG.

484. **The Practical Applications of Sociology.** Examination of uses of sociology by administrative policy-makers and community leaders, e.g., increasing industrial and agricultural productivity, reducing social conflict and group tensions; different types of applied sociology, clinical and engineering sociology; theoretical and scientific problems arising in efforts to apply sociology to practical problems and their possible solutions. I, II; 1 unit. Prerequisite: Sociology 400 or consent of instructor. GOULDNER.

485. **Sociological Prediction Methods.** An analysis of the research principles and problems involved in predicting social behavior, with special illustrations from the prediction of criminality and of adjustment to correctional supervision, from predicting marital adjustment, and from other prediction research. I or II; 1 unit. Prerequisite: Sociology 385 or equivalent. GLASER.

487. **Special Problems in Rural Sociology.** Same as Rural Sociology 487. I, II; ½ to 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

488. **European Sociological Theory.** Selected problems of contemporary sociological thought, e.g., the question of objectivity (sociology of knowledge); what constitutes sociology as a special science; the problem of social dynamics. I or II; 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. AHRENS.

489. **Readings in Sociology.** I, II; 1 unit. HULETT.

490. **Individual Topics in Sociology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. I, II; ½ to 2 units. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Sociology of Education.** Same as Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share

Western civilization. I, II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. SHIDELER.

317. **Structure and Function of Rural Society in America.** Same as Rural Sociology 317. A functional analysis of the group, institutional, and class structure of contemporary American rural society, with emphasis on regional and subregional variations and the interdependence of the rural and other segments of the total American society. I; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Three hours of sociology, eight hours of social science, or consent of instructor. FOLSE.

318. **Human Relations in Industry.** Same as Labor and Industrial Relations 318. Sociology of industry and problems of personal adjustment; the emergence of modern industrial and labor organizations and their impact upon community life. I, II; ½ or 1 unit. Registration for a full graduate unit requires both the approval of the instructor and substantial additional work. Prerequisite: Psychology 100; Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or consent of instructor. KARSH.

320. **Social Roles.** Contemporary role theory and related concepts such as social status and social interaction; age-sex, vocational, social class, and other role types; applications of this theory to the study of the socialization process and personal adjustment, and the analysis of critical group situations and social change. I or II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. HULETT.

323. **The Small Social Group.** Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. I, II; ½ or 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117. SHIDELER.

324. **Penology.** Probation; parole; methods of institutional treatment. I or II; ½ or 1 unit. Prerequisite: Sociology 331. ENGLAND.

328. **Sociology of Leisure.** Social-cultural norms, values, institutionalized behavior patterns, and group relations associated with man's use of leisure time, from the contemporary, comparative, and historical points of view; interrelations of leisure patterns with other aspects of social life such as work, technology, sociability, morality, art, and other institutions. Graduate students registering for a full unit must prepare a substantial research paper in addition to regular class assignments. I, II; ½ or 1 unit. Prerequisite: Three hours of sociology or consent of instructor.

331. **Criminology.** Nature and extent of crime; past and present theories of crime causation; criminal behavior in American society and its relation to personal and cultural conditions. I, II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. ENGLAND, GLASER.

332. **Prevention and Treatment of Juvenile Delinquency.** Conceptions of delinquency and its causation; the juvenile court movement; juvenile detention; treatment of juvenile offenders; delinquency prevention programs. I or II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or Sociology 331. ENGLAND, GLASER.

340. **Social Movements.** Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanisms. I, II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105. SHIDELER.

344. **Public Opinion.** Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. I, II; ½ unit. Pre-

requisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. ALBIG.

347. **Sociology of International Conflict.** War as a social process; conflict of national cultures; population pressures; race relations, immigration policies, restrictions on communication, and other elements in the international conflict process; occupation policies in Germany and Japan; implications of social science for changes in the process. II; ½ unit.

372. **Contemporary International Migration.** Demographic, cultural, ideological, and other factors in present-day movements of peoples; controlled and compulsory migration; immigrant groups and displaced persons in the United States; national and international migration policies. I or II; ½ unit. Prerequisite: Three hours of sociology or eight hours of social science.

375. **Sociology of the Community.** Nature, structure, and functions of the community; types of communities and examples of some better community studies; the relation of the community to the larger social organization. I or II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or eleven hours of sociology. TIMMONS.

378. **Acculturation in Modern Society.** Acculturation as a universal social process. Deals with the influence of contacts between cultures as a factor in social-cultural change. Emphasis is placed on changes in ideology, technology, and personality types as a consequence of contacts between Western, Oriental, and other civilizations. I, II; ½ or 1 unit. Prerequisite: Five hours of sociology. JANES.

385. **Methods of Sociological Research.** The application of principles of research and sampling design to sociological problems; procedures for collection and analysis of data, including the fundamentals of quantitative methods; discussion and criticism of examples of current sociological research. I, II; ½ or 1 unit. Prerequisite: Eight hours of sociology. CHANDLER.

386. **Methods of Field Research.** Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. I, II; ½ or 1 unit. Prerequisite: Three hours in advanced courses in sociology or consent of instructor. KARSH.

Anthropology

Course work is available in the three main branches of cultural anthropology (archaeology, social anthropology, and linguistics) and in physical anthropology, with opportunities for specialized training in social anthropology and archaeology. The graduate program is administered by the Anthropology Committee of the Department of Sociology and Anthropology.

Applicants for admission to first-year graduate study in anthropology must meet the following requirements in order to be admitted with full standing: (1) fulfillment of the general requirements of the Graduate College; (2) a grade-point average of at least 3.5; and (3) a general background of preparation in anthropology such as would be provided by an undergraduate major or its equivalent. A student lacking sufficient preparation in anthropology may be permitted to register for graduate courses but he is required to make up his deficiencies

to the extent prescribed by his adviser by taking specified undergraduate courses without credit.

Degree of Master of Arts. Requirements for this degree are: the satisfactory completion of an approved program of eight units of work, including an acceptable thesis which embodies the results of an original research project the plan for which must have been approved in advance by the student's committee; and the passing of a written comprehensive examination covering the major fields of anthropology (archaeology, ethnology, linguistics, physical anthropology, and social anthropology).

The student's program of work for the degree of Master of Arts is supervised by a committee consisting of the adviser and one additional member of the anthropology graduate faculty.

Degree of Doctor of Philosophy. The applicant who has obtained his Master of Arts degree from the University of Illinois is judged as to his qualifications for further advanced work on the basis of his record and his performance on the comprehensive examination taken for the master's degree. The applicant whose previous graduate work was done elsewhere may be admitted on a provisional basis and during his first semester of residence must take a comprehensive examination covering the major fields of anthropology. The results of this examination serve to determine the student's eligibility to continue in the doctoral program and to ascertain the amount of credit toward the doctoral requirements to be allowed for work completed elsewhere.

A candidate for the doctorate must complete the following courses or their equivalents: (1) in the area of linguistics, Anthropology 370 or Humanities 301; (2) in the area of physical anthropology, Anthropology 356; (3) in the area of archaeology, Anthropology 460; (4) in the area of social anthropology, Anthropology 450 and two of the following: Anthropology 361, 367, 368.

The prerequisite for a graduate minor in anthropology is six semester hours of undergraduate credit in anthropology. Before registering for courses, a student intending to offer anthropology as a minor subject should consult with the chairman of the department who will refer him to an anthropologist for advice and direction.

Upon the recommendation of his adviser, and after he has complied with the relevant regulations of the Graduate College, the student may apply in writing to the Anthropology Committee for admission to the preliminary examination. This examination tests the candidate's knowledge of his minor fields, and his proficiency in the history, theory, methods of research, and substantive content of his field of specialization in anthropology. He is also examined on his basic knowledge and understanding of the major subdivisions of anthropology that lie outside his field of specialization. An essential requirement of every candidate for the Ph.D. in anthropology is the capacity for original and creative research as demonstrated by the preparation of the doctoral dissertation. Dissertations are preferably based on field research. The student should consult with his adviser on this matter from time to time for guidance in his training in research methods and in the planning of his dissertation project.

COURSES FOR GRADUATES

450. **Seminar in Anthropology.** Analysis of selected topics of special interest in anthropology. I or II; 1 unit. Students may reregister in this course up to a total of two units. WINTER.

451. **Primitive Social Structure.** This course is intended to acquaint the student with the descriptive techniques and methods of analysis currently employed by social anthropologists in the study of primitive social groups and their modes of operation. I or II; 1 unit. WINTER.

460. **Theories and Methods in Anthropology.** A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. I or II; 1 unit. McGregor.

461. **The Cultural Approach in Anthropology.** Seminar on the historical, comparative, and holistic methods of anthropology. I or II; 1 unit. Prerequisite: Consent of instructor. Steward.

462. **Cultural Method and Contemporary Native Populations.** Seminar on the use of anthropological methods in the analysis of native populations, with special reference to studies of communities, classes, castes, and other subcultural groups. I or II; 1 unit. Prerequisite: Anthropology 461 or consent of instructor. Steward.

463. **Seminar on Field Methods and Research Designs in Cultural Anthropology.** Critical examination of field methods and research designs as reflected in selected studies covering the past seventy years, ranging from early missionary reports to those of contemporary field workers. An effort is made to discern major trends in methodology. Community studies and comparative studies on both the tribal and peasant levels are examined. I or II; 1 unit. Prerequisite: Consent of instructor. Lewis.

489. **Readings in Anthropology.** Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interests of the student. I, II; ½ to 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser. Staff.

490. **Individual Topics in Anthropology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. I, II; ½ to 2 units. Prerequisite: Consent of instructor. Staff.

499. **Thesis Research.** Preparation of theses. I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

353. **Southwestern Archaeology.** Detailed study of one archaeological unit in the United States. Covers the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. McGregor.

354. **Field Techniques in Archaeology.** An intensive six-week course in the field techniques and methods employed in American archaeology, covering all phases of such training from setting up a field camp, through excavation, recording, cataloguing, and preliminary field study to partial evaluation. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. McGregor.

355. **Laboratory Techniques and Problems in Archaeology.** Training in the laboratory methods and techniques of dealing with archaeological problems. A specific problem is assigned to each student for solution. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. McGregor.

356. **Physical Anthropology.** The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. I or II; 1 unit. Prerequisite: Anthropology 102 and 103, or, with consent of instructor, a course in anatomy or comparative anatomy, or physiology, or introductory zoology. McGregor.

361. **Ethnology of Middle America.** A survey of the peoples and cultures of Middle America with special emphasis upon Mexico and Guatemala. Begins by placing Middle America geographically, historically, and culturally within the broader Latin-American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. LEWIS.

362. **Patterns of Folk and Peasant Cultures.** An analysis of the development of folk and peasant cultures in various parts of the world. Data are drawn from archaeological and historical records as well as from contemporary ethnological studies. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

363. **Religion in Primitive Society.** An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. II; ½ or 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Anthropology 102 and 103, or consent of instructor. LEWIS.

364. **Field Work in Cultural Anthropology.** Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. LEWIS.

365. **Analysis of Field Data in Cultural Anthropology.** Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; consent of instructor. LEWIS.

367. **Cultures of Native Africa.** A survey of the native cultures of Africa with particular emphasis on the development of culture types and the patterns of behavior associated with them. II; 1 unit. Prerequisite: Sociology 104 or consent of instructor. WINTER.

368. **Peoples and Cultures of India.** A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: One course in anthropology or sociology, or consent of instructor. LEWIS.

370. **Language, Culture, and Society.** Same as Communications 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. I or II; ½ or 1 unit. MACLAY.

380. **Applied Anthropology.** The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in non-industrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. II; ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

SPANISH AND ITALIAN

(Including Portuguese)

The Department of Spanish and Italian offers courses leading to the degrees of Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are linguistics, Spanish literature, Latin-American literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 3.75. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, and consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for an advanced degree in Spanish must acquire a practical command of the language. Some knowledge of Italian or Portuguese is required. A considerable amount of parallel training in one or more other languages or literatures, such as English, French, German, Greek, or Latin, is indispensable. In any case, some Latin is required of candidates for the degree of Doctor of Philosophy. This requirement is usually met by taking a minimum of one semester of Latin, at any level suggested by the student's preparation, while in residence for the doctor's degree. In very special cases, with the consent of the adviser, Spanish literature and linguistics may be used reversibly as major and one minor. More commonly, however, the minor or minors for a major in Spanish literature or linguistics are chosen from some other language and literature, from anthropology, history, philosophy, or other pertinent subjects.

Candidates for an advanced degree or for a minor in Italian or Portuguese should consult the department. Provisions are made to fit individual cases.

Candidates for the degree of Master of Arts in the Teaching of Spanish must earn four units in Spanish, two units in education, and two units in electives. Requirements are Spanish, four units (middle group courses, one to two units, and graduate courses, two to three units); education, two units, including two of the following: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in Spanish and the electives must be selected with the approval of the adviser. The electives may be in Spanish, in Humanities 301, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the department. The adviser for candidates for this degree is Professor Joseph S. Flores, 214 Lincoln Hall.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in Spanish and Italian may be obtained from the head of the department, 218 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: W. H. Shoemaker (Head of Department), J. H. D. Allen, H. R. Kahane.
Associate Professors: J. S. Flores, Angelina R. Pietrangeli.
Assistant Professors: J. O. Crosby, F. P. Ellison.
Instructor: Mildred V. Boyer.

Spanish

COURSES FOR GRADUATES

405. Introduction to Critical Method. I; ½ unit. Allen.

411. **Spanish Literature in the Middle Ages.** I; 1 unit. Offered in 1958-1959 and in alternate years. ALLEN.

412. **Spanish Literature in the Middle Ages.** II; 1 unit. Offered in 1958-1959 and in alternate years. ALLEN.

415. **Spanish Literature in the Sixteenth Century.** I; 1 unit. Offered in 1959-1960 and in alternate years. ALLEN.

416. **Spanish Literature in the Sixteenth Century.** II; 1 unit. Offered in 1959-1960 and in alternate years. ALLEN.

417. **Seventeenth Century Literature.** I; 1 unit. Offered in 1958-1959 and in alternate years. FLORES.

418. **Seventeenth Century Literature.** II; 1 unit. Offered in 1958-1959 and in alternate years. FLORES.

421. **Modern Spanish Novel and Essay.** I; 1 unit. SHOEMAKER.

422. **Contemporary Spanish Novel and Essay.** II; 1 unit. SHOEMAKER.

425. **Renaissance and Baroque Poetry in Spain.** I, II; 1 unit.

426. **Spanish Poetry of the Nineteenth and Twentieth Centuries.** I, II; 1 unit.

431. **Spanish-American Literature, I: Mexico and Central America.** I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Spanish 303 and 304, or equivalent. ELLISON.

432. **Spanish-American Literature, II: Colombia and the Caribbean.** II; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Spanish 303 and 304, or equivalent. ELLISON.

433. **Spanish-American Literature, III: The Pacific Coast of South America.** I; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Spanish 303 and 304, or equivalent. ELLISON.

434. **Spanish-American Literature, IV: The Río de la Plata Region.** II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Spanish 303 and 304, or equivalent. ELLISON.

443. **Seminar in Galdós.** Research work in novelistic criticism. Prerequisite: Spanish 301 and 302 or Spanish 421 and 422. I; 1 unit. SHOEMAKER.

444. **Seminar in Spanish Realism and Naturalism.** Research work in nineteenth century literary theory and practice in novel and drama. II; 1 unit. Prerequisite: Spanish 301 and 302 or Spanish 421 and 422.

451. **Survey of Current Research in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. I; 1 unit. KAHANE.

452. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. II; 1 unit. KAHANE.

453. **History of the Spanish Language.** I; 1 unit. KAHANE.

454. **Old Spanish.** II; 1 unit. KAHANE.

491. **Special Topics in Spanish.** I, II; ½ to 1 unit. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. ALLEN, KAHANE, SHOEMAKER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Survey of Spanish Literature.** I; ½ unit. Prerequisite: Spanish 202 or equivalent. ELLISON.

302. **Survey of Spanish Literature.** II; ½ unit. Prerequisite: Spanish 202 or equivalent. FLORES.

303. **Survey of Spanish-American Literature.** I; ½ unit. Prerequisite: Spanish 202 or equivalent. ELLISON.

304. **Survey of Spanish-American Literature.** II; ½ unit. Prerequisite: Spanish 202 or equivalent. Ellison.

311. **Cervantes.** Introduction to the works of Cervantes, with particular emphasis on *Don Quixote*. I, II; ½ unit. Offered in alternate semesters with Spanish 314. Prerequisite: Spanish 202 or equivalent, or senior standing or consent of instructor. Crosby.

314. **Spanish Drama of the Golden Age.** I, II; ½ unit. Offered in alternate semesters with Spanish 311. Prerequisite: Spanish 202 or equivalent.

321. **Modern Spanish and Spanish-American Drama.** I; ½ unit. Prerequisite: Spanish 202 or equivalent. Pietrangeli.

322. **Modern Spanish and Spanish-American Drama.** II; ½ unit. Prerequisite: Spanish 202 or equivalent. Pietrangeli.

331. **La Cultura Hispánica: España.** I; ½ unit. Ellison.

351. **Phonetics.** I, II; ½ unit. Prerequisite: Spanish 202 or equivalent. Flores.

352. **Syntax.** I, II; ½ unit. Prerequisite: Spanish 202 or equivalent. Kahane.

371. **Spanish for Teachers.** A consideration of language problems suggested by teaching experience. S; ½ unit. Prerequisite: Spanish 104 or equivalent. Flores.

Italian

COURSES FOR GRADUATES

411. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** I; 1 unit. Offered in 1958-1959 and in alternate years. Pietrangeli.

412. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** II; 1 unit. Offered in 1958-1959 and in alternate years. Pietrangeli.

415. **Italian Literature of the Renaissance.** I; 1 unit. Offered in 1959-1960 and in alternate years. Pietrangeli.

416. **Italian Literature of the Renaissance.** II; 1 unit. Offered in 1959-1960 and in alternate years. Pietrangeli.

451. **History of the Italian Language.** I; 1 unit. Kahane.

452. **Seminar in Italian Linguistics.** II; 1 unit. Kahane.

491. **Special Topics in Italian.** I, II; ½ to 1 unit. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Kahane.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Dante: La Divina Commedia.** I; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. Pietrangeli.

312. **Dante: La Divina Commedia.** Continuation of Italian 311. II; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. Pietrangeli.

321. **Modern Italian Literature.** I; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Italian 101 and 102; Italian 103 and 104 are desirable.

322. **Modern Italian Literature.** II; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable.

Portuguese

COURSES FOR GRADUATES

491. **Special Topics in Portuguese.** I, II; ½ to 1 unit. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. ALLEN, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Brazilian Literature.** Survey of the contemporary Brazilian novel. I; ½ unit. Prerequisite: Portuguese 101 and 102. Portuguese 103 and 104 are desirable. ALLEN.

302. **Introduction to Portuguese Literature.** Survey of the Golden Age of Portuguese. II; ½ unit. Prerequisite: Portuguese 101 and 102. Portuguese 103 and 104 are desirable. ALLEN.

SPEECH

The Department of Speech offers courses leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy.

The admission requirement, in terms of grade-point average, is at least 3.5.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theater, oral interpretation, speech science, speech and hearing disorders. They may also select a special curriculum in the teaching of speech.

For the degree of Master of Science, students may take a special curriculum in speech correction.

For the degree of Doctor of Philosophy, students may exercise one of three options: rhetoric and public address; the theater; speech science, speech and hearing disorders.

In addition to the general regulations of the Graduate College with respect to entrance, distribution of credits, examinations, and theses, the Department of Speech specifies the requirements listed below.

Degree of Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech. If he does not present sixteen hours of credit in speech, he must make up the deficiency before he can be regarded as a candidate for a graduate degree. His record should include these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theater, and an advanced course in public speaking or discussion.

In consultation with the head of the department, the candidate chooses an adviser with whom he should confer about all details of his program.

A normal program of study requires eight graduate units (four each semester) for graduation. The student with a well-rounded undergraduate education may take all eight units in speech; other students are expected to declare a major in speech (to consist of at least four units) and one or two minors in related fields of study outside the department. As a rule, a minor does not exceed two units.

Whether or not a thesis is presented depends upon the candidate's educational and professional aims. After consultation with the student, the student's adviser and the head of the department decide in each case whether a thesis should be submitted as part of the degree requirements. Students who expect to go on to a doctor's degree as a rule are required to present a thesis.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated. The examination covers in part the general field of speech and in part the candidate's area of specialization.

Degree of Master of Arts in the Teaching of Speech. Candidates for the Master of Arts degree who are interested in public school teaching should meet the following requirements:

(1) In the area of rhetoric and public address: Speech 311 and 312, one-half unit each; Speech 322 and 423, one unit each; and education, two units, including two of the following: Education 301, 302, 303, 304, one unit, and Education 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of the theater: speech, four units, including Speech 361 or 362 or 366, 352, 451, 452; education, two units, including two of the following: Education 301, 302, 303, 304, and Education 311 and 312; electives, two units.

Degree of Master of Science in Speech Correction. This program is designed for teachers who desire to obtain an advanced degree in speech correction. The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all of the requirements may register on approval of the adviser and complete the prerequisites during the first year of graduate study.

Requirements include four units of speech selected from the following: Speech 387, 475, 476, 481, 486, 488, 489, 491, 495; one unit from Education 301, 302, 303, 304, and one unit from Education 311 and 312; two units of electives. The electives may be in speech, in education, in psychology, or, in exceptional cases, in other fields.

Degree of Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree from an accredited institution. In consultation with the head of the department, the doctoral candidate, like the master's candidate, secures a departmental adviser.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in speech may be obtained from the head of the department, 204a Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: K. R. Wallace (Head of Department), E. T. Curry, G. Fairbanks, B. Hewitt, L. S. Hultzén, R. Murphy, Severina E. Nelson, J. W. Swanson.

Associate Professors: O. A. Dieter, H. E. Gulley, Marie K. Hochmuth, J. C. Kelly, H. L. Mueller, R. E. Nadeau, J. W. Scott, C. H. Shattuck, K. A. Windesheim.

Assistant Professors: Clara M. Behringer, K. Burns, M. T. Cobin, C. L. Hutton.

Instructor: W. Smalley.

COURSES FOR GRADUATES

403. **Seminar for Teachers of Speech.** Investigations of current principles, materials, and developments in the field of speech and of their relationship to the teacher. I, II; 1 unit. Burns.

411. **The Greek Tradition in Rhetoric and Oratory.** The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to the Renaissance; analysis of the contributions of major figures and works to that tradition. I; 1 unit. Nadeau.

412. **The Roman Tradition in Rhetoric and Oratory.** Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. II; 1 unit. Dieter.

423. **The Rhetoric of Aristotle.** Study of the *Rhetoric* in relation to other works of Aristotle. I; 1 unit. WALLACE.

430. **Contemporary Theories of Oral Communication.** Systematic study of speech-making and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. I or II; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Consent of instructor. GULLEY.

436. **Seminar in Public Discussion.** Investigation of special problems in public discussion. II; 1 unit. Offered in 1958-1959 and in alternate years. MURPHY.

438. **Seminar in Rhetorical Theory.** Study of special topics in the history of rhetorical theory. II; 1 unit. WALLACE.

441. **Principles and Theories of Oral Interpretation.** Historical survey of British and American theories of interpretation. I; 1 unit. COBIN.

442. **Seminar in Oral Interpretation.** Investigation of basic problems in the history, nature, and function of oral interpretation. II; 1 unit. Prerequisite: Speech 441; consent of instructor. COBIN.

451. **Problems in Play Directing in the School Theater.** Study of the audience, play selection, the actor's abilities and needs, try-outs and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. I; 1 unit. SWANSON.

452. **Problems in Play Production in the School Theater.** Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. II; 1 unit. SWANSON.

461. **Advanced Theater Techniques.** Individual development of advanced techniques of acting and staging through supervised participation in public productions. S; ½ to 1 unit. Prerequisite: At least one semester of graduate study in the area of theater; consent of head of the department and instructor. BEHRINGER.

463. **Seminar in the History of Acting.** Studies in the history and theory of the art of acting. II; 1 unit (students may accumulate 2 units). Offered in 1959-1960 and in alternate years. SHATTUCK.

465. **Seminar in Theater Art.** Studies in the aesthetics of the theater. I; 1 to 2 units. HEWITT.

468. **Seminar in Theater History.** Studies in the history of the theater. II; 1 to 2 units. HEWITT.

472. **Psychoacoustics of Speech.** Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. II; 1 unit. Prerequisite: Consent of instructor. CURRY.

473. **Seminar in Phonetics.** Same as Communications 442. Advanced study in phonetic theory and noninstrumental phonetic investigation. I or II; 1 unit. Prerequisite: Consent of instructor. HULTZÉN.

475. **Experimental Phonetics, I.** Same as Communications 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. I; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

476. **Experimental Phonetics, II.** Same as Communications 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the

experimental literature. II; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

477. **Measurement of Speech, I.** Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. I; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. FAIRBANKS.

478. **Measurement of Speech, II.** Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. II; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. FAIRBANKS.

479. **Seminar in Experimental Phonetics.** Same as Communications 479. Advanced consideration of experimental research in the physiological, acoustical, and psychophysical aspects of speech and hearing. Extensive survey of current literature. S; 1 unit. Prerequisite: Speech 475 and 476, or consent of instructor. FAIRBANKS.

481. **Seminar in Voice and Articulation Disorders.** Advanced study of voice and articulation disorders; survey of research and theory; principles of therapy. I or II; 1 unit. Prerequisite: Consent of instructor. KELLY.

486. **Advanced Clinical Techniques in Speech and Hearing.** Practice of advanced clinical therapy for speech and hearing disorders; semi-independent management of complex difficult cases; participation in examination and analysis. I, II; 1 to 4 units. Prerequisite: Consent of instructor. CURRY, NELSON.

488. **Diagnosis of Speech Disorders.** Study of diagnostic procedures used in analysis of symptoms involved in speech disorders. II; 1 unit. NELSON.

489. **Seminar in Organic Speech Disorders.** Principles and methods of clinical and classroom correction of speech disorders associated with organic dysfunctions. I or II; 1 unit. Prerequisite: Consent of instructor. NELSON.

491. **Seminar in Hearing Disorders.** Principles and methods of clinical and classroom management of all types of hearing disorders. Survey of current literature and research. I or II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Speech 391.

495. **Special Problems.** Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. I, II; 1 to 2 units. Prerequisite: Consent of the head of the department. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. COBIN, CURRY, DIETER, FAIRBANKS, GULLEY, HEWITT, HOCHMUTH, HULTZÉN, KELLY, MURPHY, NELSON, SHATTUCK, SWANSON, WALLACE, WINDESHEIM.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Phonetics.** Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. I, II; ½ to 1 unit. HULTZÉN, MUELLER.

311. **British Public Address.** Study of representative British speakers from the sixteenth century to the present. Lectures, reports, and papers. I; ½ to 1 unit. Prerequisite: Speech 117 or 221. MURPHY.

312. **American Public Address.** Study of representative American speeches from the sixteenth century to the present. II; ½ to 1 unit. Prerequisite: Speech 117 or 221. HOCHMUTH.

322. **Modern Rhetorical Theory.** Significant movements in the development of rhetorical theory in England, France, and America from 1700 to 1950. I or II; ½ to 1 unit. HOCHMUTH.

342. **Advanced Oral Interpretation.** Oral interpretation of poetry. I, II; ½ to 1 unit. Prerequisite: Speech 141. COBIN.

352. **Theories of Play Production.** Origin and development of modern theatrical production; a critical examination of contemporary ideas and practices in theater architecture, acting, directing, and staging. I; ½ to 1 unit. SWANSON.

353. **Creative Dramatics for Children.** A study of the subject matter and techniques of creative dramatics for children, with laboratory application. S; ½ to 1 unit. Prerequisite: Consent of instructor.

354. **Theater for the Child Audience.** A study of the history, the objectives, and the techniques of play production for the child audience, with laboratory application. S; ½ to 1 unit. Prerequisite: Consent of instructor.

355. **Advanced Play Directing.** A study of advanced directing techniques; styles of drama; specialized procedures. I or II; ½ to 1 unit. Prerequisite: Speech 255 or equivalent. SWANSON.

361. **History of the European Theater to the Renaissance.** The theater and the theater arts of ancient and of medieval Europe. I; ½ to 1 unit. SCOTT.

362. **History of the European Theater from the Renaissance to 1900.** The European theater and the theater arts from 1576 to 1900, with special reference to the English theater. II; ½ to 1 unit. SCOTT.

363. **Advanced Playwriting.** Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing the full-length play. I, II; ½ to 1 unit (students may accumulate 2 units). Prerequisite: Speech 263; consent of instructor. SMALLEY.

366. **Development of the American Theater.** The development of the theater and theater arts in America from colonial times to the beginning of the twentieth century. I or II; ½ to 1 unit. HEWITT.

368. **History of Theater Costume.** A survey of the history of costumes worn on the stage from the classical Greek period to the present. II; ½ to 1 unit. RICHARDSON.

370. **Stage Scenery Design.** Theory and practice of designing stage scenery. II; ½ to 1 unit. Prerequisite: Speech 157 and two of the following: Speech 255, 352, 361, 362; or consent of instructor. SCOTT.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as English 371. I; ½ to 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as English 372. II; ½ to 1 unit. HERRICK.

373. **Phonetics and Phonemics.** Methodologies of phonetics with special application to English; general principles of phonemic interpretation. I or II; ½ to 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Speech 301. HULTZÉN.

375. **Speech Science.** Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. I, II; ½ unit. Prerequisite: Consent of instructor. CURRY.

376. **Speech Science.** Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. II; ½ unit. Prerequisite: Speech 375 or consent of instructor. CURRY.

385. **Speech Correction.** Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation and practice in clinical techniques are provided in the laboratory. I; ½ unit. Prerequisite: Ten hours of speech or consent of instructor. NELSON.

386. **Practicum in Speech Diagnosis and Therapy.** Observation, practice, and research in diagnosis and therapy of speech disorders. I, II; ½ unit. Prerequisite: Speech 385. NELSON.

387. **Voice and Articulation Disorders.** Principles and methods of clinical and classroom correction of voice and articulation disorders. I or II; ½ unit. Prerequisite: Speech 385; consent of instructor. KELLY.

388. **Speech Correction.** Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and glandular disorders. II; ½ to 1 unit. Prerequisite: Speech 385. NELSON.

391. **Introduction to Hearing Disorders.** Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. I or II; ½ unit. Prerequisite: Speech 301 and 375, or consent of instructor. CURRY.

393. **Aural Rehabilitation.** Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling; clinical and classroom practice with children and adults. I, II; ½ unit. Prerequisite: Speech 391; consent of instructor. Required in the curriculum of teacher training in speech correction. HUTTON.

395. **Audiometry and the Use of Hearing Aids.** Selective and diagnostic tests of hearing, the planning and conduct of hearing conservation programs, general problems involved in the use of hearing aids. I, II; ½ unit. Prerequisite: Speech 376. CURRY, HUTTON.

THEORETICAL AND APPLIED MECHANICS

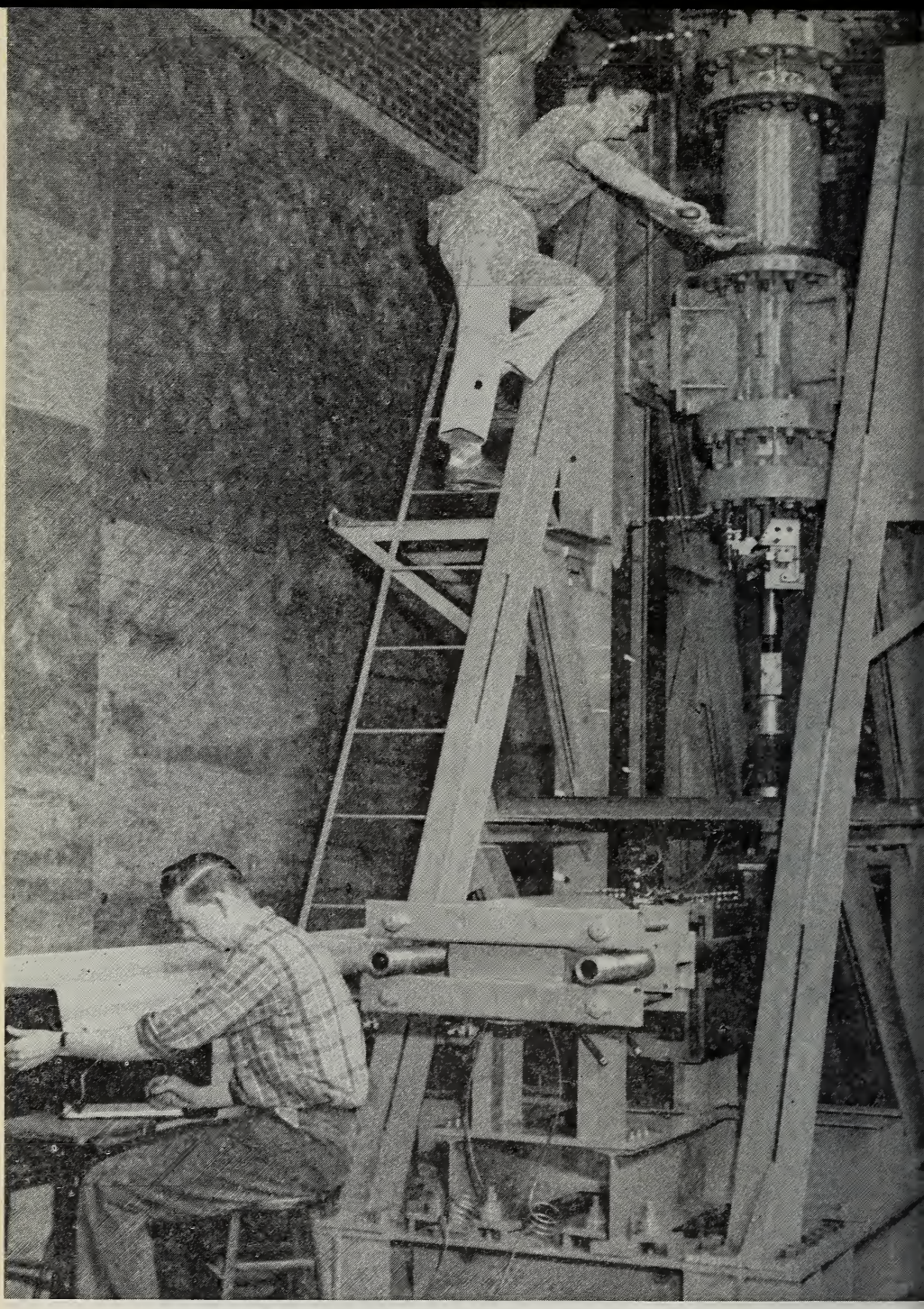
The Department of Theoretical and Applied Mechanics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

Graduate students electing theoretical and applied mechanics as their major must have had the equivalent of the undergraduate courses in mechanics required for a bachelor's degree in any of the curricula in the College of Engineering. Admission to graduate study in this department requires a 3.5 grade-point average.

Candidates for the Doctor of Philosophy degree are required to take, in addition to the thesis, advanced calculus and at least one-half unit from each of the following areas in the department: (1) advanced analytical methods in mechanics, (2) dynamics or vibrations, (3) fluid mechanics, (4) mechanics of solids.

The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science degree is one unit; for the Doctor of Philosophy degree, the requirement for a first minor is four units and for a second minor, two units.

In the program for graduate study, emphasis is placed on both course work and research, the latter being either analytical or experimental. The department, as part of the Engineering Experiment Station, conducts many research investigations and makes studies of importance to the engineering, manufacturing, and other industrial interests as well as to various governmental agencies. Some of



A special testing machine developed to study the behavior of structural materials under dynamic loads.

the fields of greatest research activity are properties of materials and the elastic and inelastic behavior of load-resisting members; fatigue of metals; properties and behavior of plain concrete, reinforced concrete beams, columns, footings, slabs, and frames; creep of metals and of plastics and other inelastic behavior of materials; hydraulics and fluid mechanics; stresses in railway car wheels, rails and bolted and welded rail joints; mechanical vibrations of machines and structures and vibration damping; photoelastic, electric strain gage, and other methods of experimental stress analysis; materials subjected to static and dynamic loads; theoretical analyses of problems in fluid flow, dynamics, theory of elasticity, and theory of plasticity. Controlled environment facilities are available for investigations of plastics and plain and reinforced concrete.

For information concerning applied mathematics, see page 196.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in theoretical and applied mechanics may be obtained from the head of the department, 212 Talbot Laboratory.

GRADUATE TEACHING FACULTY

Professors: T. J. Dolan (Head of Department), C. E. Bowman, W. L. Collins, P. G. Jones, C. E. Kesler, H. L. Langhaar, W. M. Lansford, J. M. Robertson, H. J. Schrader, O. M. Sidebottom, G. M. Sinclair, J. O. Smith, C. E. Taylor.

Associate Professors: A. P. Boresi, M. E. Clark, H. T. Corten, M. C. Stippes, H. R. Wetenkamp, W. J. Worley.

COURSES FOR GRADUATES

412. **Vibration Analysis.** Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's method; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; non-linear systems. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 311. Jones, Stippes.

416. **Energy Principles in Engineering Mechanics.** Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation, and applications of the principle of virtual displacements, the principle of minimum potential energy, the principle of complementary energy, Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion constitute the main part of the course. Variational methods of approximation are treated briefly. The material includes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. II; 1 unit. Langhaar.

421. **Mechanics of Materials.** Methods of obtaining relations between loads, deformations, stresses and strains in various members. The main topics covered in this course and in Theoretical and Applied Mechanics 422 are curved beams, unsymmetrical bending, thick-walled cylinders, beams on elastic supports, contact stresses, torsion of members with non-circular cross-section, stress concentrations, elastic energy methods applied to statically indeterminate members, flat plates, inelastic behavior of various types of members. Introduction to mathematical theory of elasticity; elastic and plastic buckling;

criteria of failure by yielding and by fracture. I; ½ to 1 unit. SIDEBOTTOM, SMITH.

422. **Mechanics of Materials.** Continuation of Theoretical and Applied Mechanics 421. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 421. SIDEBOTTOM, SMITH.

424. **Properties of Engineering Materials.** Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. II; ½ to 1 unit. COLLINS.

427. **Theories of Mechanical Properties and Behavior of Plain Concrete.** Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial are emphasized. The studies involve critical reviews of experimental and analytical investigations. I; ½ to 1 unit. KESLER.

431. **Theory of Ideal Fluid Flow.** Together with the following course, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible viscosity. The differential equations of motion are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. I; 1 unit. Prerequisite: An elementary course in fluid flow and a course in advanced calculus or equivalent. ROBERTSON.

432. **Theory of Flow of Viscous Fluids.** Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially. Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. II; 1 unit. Prerequisite: An elementary course in fluid flow and a course in differential equations or in advanced calculus. ROBERTSON.

441. **Applied Analysis in Engineering.** A course to provide training in applications of mathematics to engineering problems. Most of the illustrations are taken from engineering mechanics. I; 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. LANGHAAR.

442. **Applied Analysis in Engineering.** Continuation of Theoretical and Applied Mechanics 441. II; 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. LANGHAAR.

451. **Theory of Elasticity with Application to Engineering Problems.** A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with

special consideration given to their significance in engineering problems. I; 1 unit. Boresi, Stippes.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Boresi, Stippes.

454. **Theory of Shells.** A course designed to provide the theoretical basis of stress analysis of shell-type structures, such as ships, submarines, monocoque aircraft structures, concrete roofs and domes, pressure vessels, and containers for liquids. The material includes the differential geometry of shell theory, equilibrium equations, momentless theory of shells, strains in shells, statically indeterminate problems of shells, energy formulations, and stability of shells. II; 1 unit. Prerequisite: Mathematics 343 or equivalent; Theoretical and Applied Mechanics 451 is desirable but not required; Mathematics 341 or 345 is desirable. Langhaar.

461. **Inelastic Behavior of Engineering Materials (Theory of Plasticity).** An outline of a general theory of inelastic behavior involving the relations between loads and stresses and strains in various members that are stressed beyond the elastic range. The cases considered include those in which the inelastic actions involve bodies which are made of materials that behave ideally viscous, ideally plastic, and combinations of the two. Some specific topics are mechanisms of inelastic action of members in which the stresses and strains are essentially uni-axial, such as straight beams, curved beams, and members subjected to combined axial and bending loads; deflection of beams; statically indeterminate members loaded inelastically; inelastic buckling; "shake down" of simple statically indeterminate members; etc. I; ½ to 1 unit. Smith.

462. **Inelastic Behavior of Engineering Materials (Theory of Plasticity).** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading functions. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. Smith.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. II; ½ to 1 unit. Langhaar.

493. **Advanced Independent Study (Special Problems).** Individual investigation of studies, either analytical or experimental, in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. I, II; ½ to 2 units. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Mechanical Vibrations.** Kinematics of vibratory motion; comprehensive study of vibrating systems having a single degree of freedom. Specific topics are natural frequencies in undamped vibration and the energy (Rayleigh) method; viscous, Coulomb, and solid (hysteresis) damping; forced vibration;

work done by harmonic forces; method of complex algebra; critical speeds and balancing; balancing machines; vibration isolation; vibration instruments. For systems with several degrees of freedom, specific topics are modes; coupled vibrations; vibration absorbers and dampers; vehicle suspension; Holzer's analysis for torsional systems. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 154 or 156, or 211 and 221. JONES.

321. **Advanced Mechanics of Materials.** Methods used in elementary mechanics of materials are expanded and generalized and used to solve more complex problems. Thick-walled cylinders, torsion of bar having non-circular cross-section; curved beams, unsymmetrical bending, flat plates; theories of failure. Use of energy methods for determining deflections and for solving statically indeterminate problems. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. SIDEBOTTOM, SMITH.

323. **Advanced Laboratory in Materials Testing.** Calibration of testing machines and of strain measuring instruments. Use of various mechanical and electrical strain gages; determination of the mechanical properties of five different materials under various types of tests: tension, compression, torsion, flexure, impact, and hardness; interpretation of test results. Relation of tests to specifications of materials. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. COLLINS, WETENKAMP.

326. **Experimental Stress Analysis.** Measurement of strains or deformations that are of significance in the engineering design of load resisting members. Systematic applications of optical, electrical, and physical properties of matter to the instrumentation and measurement of model or prototype stresses. The methods studied include models, analogies, brittle coatings, electrical resistance gages, photoelasticity, etc. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 221, and 223. Theoretical and Applied Mechanics 321 is desirable. BOWMAN.

334. **Fluid Mechanics and Advanced Hydraulics.** A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. LANSFORD.

346. **Dimensional Analysis and Theory of Models.** The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. I; ½ to 1 unit. LANGHAAR.

VETERINARY MEDICAL SCIENCE

Candidates for the Master of Science and Doctor of Philosophy degrees in Veterinary Medical Science must have a Bachelor of Science or a Doctor of Veterinary Medicine degree from a college or university approved by the University of Illinois. If they do not have a veterinary degree, their undergraduate training must be approved by the graduate faculty of the department as appropriate to advanced study. They must have a minimum grade-point average of 3.5.

Areas of specialized study in veterinary medical science include anatomy, microbiology, parasitology, pathology, physiology, and pharmacology.

Students who intend to take graduate work for a Master of Science or Doctor of Philosophy degree in Veterinary Medical Science should include in their under-

graduate program at least five hours of physics or mathematics, fourteen hours of chemistry, and fifteen hours of biological sciences. A student who is deficient in these subjects may enter the Graduate College but is required to take the prerequisite courses without graduate credit to remove the deficiency during the first year of residence.

Each graduate student, upon initiation of his program, should arrange with his adviser for orientation by an advisory committee consisting of three or more faculty members. No fewer than three of the areas in the Veterinary Medical Science department should be represented on this committee. The meeting with the committee may be arranged at the beginning of each fall semester; additional meetings may be arranged during the year at the discretion of the student and adviser.

Students planning to work toward the Doctor of Philosophy degree who enter the University of Illinois without previous graduate training are evaluated by the graduate faculty of the department at the end of their first year of residence in order to determine whether their progress is acceptable for work toward the doctorate. This evaluation is based in part upon an examination.

Students planning to work toward the Doctor of Philosophy degree who enter the University of Illinois with previous graduate training must present a transcript of their completed graduate courses to the head of the department preceding approval for further study to determine what transfer credit toward the doctoral requirements will be allowed for work completed elsewhere. Prior to the end of the first year of residence, an evaluation of the student's progress toward the doctoral requirement is made by the graduate faculty of the department. The evaluation is based in part upon an examination.

Departmental requirements for the degree of Master of Science or Doctor of Philosophy in Veterinary Medical Science, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department. This pamphlet also contains more detailed descriptions of the courses in veterinary medical science and suggests appropriate course sequences.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in veterinary medical science may be obtained from the dean of the college, 131 Veterinary Medicine Building.

GRADUATE TEACHING FACULTY

Professors: C. A. Brandly (Head of Department), J. O. Alberts, P. D. Beamer, L. E. Boley, R. D. Hatch, A. B. Hoerlein, N. D. Levine, R. P. Link, L. E. St. Clair, J. Sampson.

Associate Professors: D. H. Ferris, H. J. Hardenbrook, E. F. Reber.

Assistant Professors: L. E. Hanson, A. M. Watrach.

COURSES FOR GRADUATES

408. **Principles of Hematology.** The cellular morphology of the blood and bone marrow of animals in health and disease. Lectures, discussions, demonstrations, and laboratory. II; ½ unit. Prerequisite: Veterinary Medical Science 311 or equivalent, or consent of instructor. St. Clair.

415. **Advanced Veterinary Microbiology.** Advanced study of bacteria spirochetes, pleuropneumonia-like organisms, rickettsiae, and viruses of domestic animals. I; 1 unit. Prerequisite: Bacteriology 326 or Veterinary Medical Science 323, or equivalent. Alberts, Hoerlein.

416. **Epizootiology.** Principles and problems of epizootiology with special consideration of the zoonoses; ecology, perpetuation, and distribution; the principles

and factors in interference, carrier, and latent states, reservoirs and control. II; 1 unit. Prerequisite: Bacteriology 300 and Veterinary Medical Science 323 or equivalent; consent of instructor. BRANDLY, FERRIS, LEVINE.

430. **Advanced Veterinary Parasitology.** Isolation, identification, cultivation, chemotherapy, and host-parasite relations of protozoan, helminth, arthropod, and fungal parasites of domestic animals. II; ½ to 1 unit. Prerequisite: Veterinary Pathology and Hygiene 324 or Zoology 318 and 321, or equivalent; Chemistry 133 or equivalent. LEVINE.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy 440, Animal Science 440, Dairy Science 440, and Horticulture 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. JACOB.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy 441, Animal Science 441, Dairy Science 441, and Horticulture 441. A continuation of Veterinary Medical Science 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Veterinary Medical Science 440 or equivalent. JACOB.

445. **Advanced Macroscopic Pathology.** Concepts and interpretations of gross pathological changes and the integration of host-parasite reactions. I, II; ½ to 1 unit. Prerequisite: Veterinary Medical Science 325 and 326 or equivalent and consent of instructor. ALBERTS, BEAMER.

450. **Advanced Veterinary Pathology.** Advanced study of gross and microscopic pathology of diseases of domestic animals. Prerequisite: Veterinary Pathology and Hygiene 326 or equivalent. I; 1 unit. BEAMER.

460. **Advanced Veterinary Physiology.** Advanced study of physiology, nutrition, and biochemistry as related to problems in veterinary medical science. Problems studied include white muscle disease, sweet clover disease, ketosis, hypoglycemia, and digestive disturbances. Laboratory includes planning, executing, and reporting a specific course project. I; 1 unit. Prerequisite: Veterinary Medical Science 321, 322, or equivalent; consent of instructor. REBER, SAMPSON.

461. **Advanced Veterinary Pharmacology.** Evaluation of drugs, pharmacological aspects of biological antagonisms, antimetabolites, chemotherapy, antibiotics, chelating agents, and chemical-biological correlations. II; ¾ unit. Prerequisite: Veterinary Medical Science 330 or consent of instructor. LINK.

490. **Seminar.** Required of all graduate students whose major is veterinary medical science. I, II; 0 to ¼ unit. BRANDLY and staff.

491. **The Experimental Method in Veterinary Research.** Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. I; ½ unit. LEVINE.

492. **Special Problems.** Basic and applied study including orientation and research on pertinent initial and continuing problems in the student's area of interest. (Not more than one unit of Veterinary Medical Science 492 may be offered toward an M.S. degree or two units toward a Ph.D. degree. I, II; ¼ to 1 unit. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Gross Anatomy.** Systematic and topographic study and dissection of the dog. I; 1 unit. Prerequisite: Five hours of zoology; consent of instructor. ST. CLAIR.

312. **Gross Anatomy.** Comparative study and dissection of the domestic animals, with special reference to development and adaptation to function. II; 1 unit. Prerequisite: Veterinary Medical Science 311 or consent of instructor. St. Clair.

313. **Histology and Embryology.** Structure and development of cells and tissues with special reference to domestic animals. I; 1 unit. Prerequisite: Five hours of zoology; consent of instructor. Safanie.

314. **Histology and Embryology.** Structure and development of organs and systems with comparison in different domestic animals. II; 1 unit. Prerequisite: Veterinary Medical Science 313 or consent of instructor. Safanie.

321. **Physiology.** Blood and lymph, circulation, respiration, digestion, absorption, and excretion. Lectures, quizzes, demonstrations, and laboratory. I; 1 unit. Prerequisite: Courses totaling twenty semester hours in chemistry or animal biology, or both; consent of instructor. Sampson.

322. **Physiology.** Metabolism, heat production, endocrine organs, muscle and nerve, central nervous system, special senses, and reproduction. Lectures, quizzes, demonstrations, and laboratory. II; 1 unit. Prerequisite: Courses totaling twenty semester hours in chemistry or animal biology, or both; consent of instructor. Sampson.

323. **Bacteriology and Immunology.** Cultural requirements, propagation, isolation, and identification of microbial agents causing disease of domestic and wild animals; serological methods and immunological concepts. Lectures, quizzes, laboratory. I; 1 unit. Prerequisite: Bacteriology 300; consent of instructor. Hanson.

324. **Parasitology.** Protozoa, helminths, arthropods, and other parasites affecting domestic animals. Prerequisite: Courses totaling twenty hours in chemistry or animal biology, or both; consent of instructor. I; 1 unit. Levine.

325. **General Pathology.** The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasms. Lectures, quizzes, demonstrations, and laboratory. II; 1 unit. Prerequisite: Courses totaling twenty-five hours in histology, parasitology, physiology, and microbiology; consent of instructor. Watrach.

326. **Special Pathology.** Disease processes affecting organs and anatomic systems and those occurring in specific diseases. Lectures, quizzes, demonstrations, and laboratory. I; 1 unit. Prerequisite: Veterinary Medical Science 325 or equivalent; consent of instructor. Beamer.

327. **Parasitology.** Protozoa, helminths, arthropods, and other parasites affecting domestic animals. I; ½ unit. Prerequisite: Credit or registration in Veterinary Medical Science 324; consent of instructor. Levine.

329. **Pharmacology.** General principles of pharmacy and an analysis of the action of chemical agents on physiological processes. Lectures and discussion. II; ½ unit. Prerequisite: Credit or registration in Veterinary Medical Science 321 and 322; consent of instructor. Link.

330. **Pharmacology.** Principles of drug action and an analysis of the action of chemical agents on living organisms. II; 1 unit. Prerequisite: Veterinary Medical Science 329 or consent of instructor. Link.

361. **Histological and Histochemical Methods.** Cellular activities and chemical reactions of tissues; methods and techniques employed in studying microscopic anatomy. Lectures, discussions, demonstrations, and laboratory. I; ½ to 1 unit. Prerequisite: Five hours of zoology. St. Clair.

362. **Preparations in Gross Anatomy.** Methods used in preparing specimens for the museum and for use in studying gross anatomy. II; ½ to 1 unit. Prerequisite: Five hours of zoology. St. Clair.

363. **Principles of Macroscopic Pathology.** Methodology of antemortem and necropsy examinations; function of protocols; description and definition of gross lesions. I, II; ½ to 1 unit. Prerequisite: Veterinary Medical Science 325 and 326, or equivalent; consent of instructor. ALBERTS, BEAMER.

ZOOLOGY

The Department of Zoology offers work leading to the degrees of Master of Science and Doctor of Philosophy.

Graduate students who choose zoology as a major must have had at least two years of undergraduate work in zoology. Students applying for admission must have a 3.75 grade-point average.

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology. Requirements for a minor in zoology are as follows:

Sole Minor: Four units in zoology, at least one of which must be in work open to graduate students only.

First Minor: Three units in zoology, at least one of which must be in work open to graduate students only.

Second Minor: Any two units in zoology offering graduate credit. Students from other departments must have had a strong undergraduate background in zoology.

A reading knowledge of German and French is indispensable for graduate study in zoology, and familiarity with Latin and Greek is of great advantage.

Graduate students whose major is zoology are strongly advised to study at least one summer at a marine biological station. Every candidate for the Doctor of Philosophy degree in zoology must furnish evidence of having completed satisfactorily at least six weeks of work at an approved station before being allowed to take the preliminary examination for the doctorate.

Although no special degree in wildlife management is offered, students may prepare themselves for that type of work by selecting courses from the following list: Zoology 304, 318, 321, 335, 336, 337, 338, 343, 345, 418, 445, 446, and research courses. Such students should choose their minors from botany, physiology, entomology, and bacteriology.

For the degree of Master of Science in the Biological Sciences or in the Teaching of the Biological Sciences and General Science, see page 59.

Special information relating to departmental standards and requirements and chief fields of specialization within the department may be obtained by writing to the chairman of the department, 345 Natural History Building.

FELLOWSHIPS AND ASSISTANTSHIPS

Information concerning fellowships and assistantships in zoology may be obtained from the chairman of the department, 345 Natural History Building.

GRADUATE TEACHING FACULTY

Professors: F. B. ADAMSTONE, B. V. HALL, L. INGLE, S. C. KENDEIGH, W. M. LUCE, S. M. ROSE, L. J. THOMAS.

Associate Professors: J. B. KITZMILLER (Chairman of Department), J. O. CORLISS, D. F. HOFFMEISTER, F. J. KRUIDENIER, M. R. MATTESON, H. H. SHOEMAKER, H. M. SMITH.

Assistant Professor: R. S. BADER.

Instructor: W. J. BIRGE.

COURSES FOR GRADUATES

403. **Cytology.** Structure and organization of the animal cell. I; 1 unit. Prerequisite: Consent of instructor. ADAMSTONE.

404. **Experimental Cytology.** An experimental approach to knowledge of the chemical and physical structure of cells. II; 1 unit. Prerequisite: Zoology 403; consent of instructor. BIRGE.

409. **History of Zoology.** The development of zoological concepts from the classical Greek period to the present. I; ½ to 1 unit. ROSE.

411. **Discussions in Genetics and Cytogenetics.** Same as Botany 411. I, II; ¼ unit. KITZMILLER, LAUGHNAN, LUCE, RHOADES.

418. **Advanced Protozoology.** Selected topics, with lectures, discussions, readings, and reports; laboratory practice in modern techniques, studying free-living and parasitic forms; collecting trips. II; 1 unit. Prerequisite: Zoology 318 or equivalent. CORLISS.

422. **Advanced Helminth Parasitology.** Advanced study of modern methods in helminthology. II; 1 unit. Prerequisite: Zoology 321 or equivalent. THOMAS.

424. **Invertebrate Taxonomy.** Individual problems in taxonomy of invertebrates. II; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Zoology 304. MATTESON.

432. **Classification, Phylogeny, and Evolution of Vertebrates.** I; 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Zoology 132. SMITH.

433. **Embryology.** A study of initial differences in developing systems and interactions leading to more complex differences. I; 1 unit. Prerequisite: Zoology 333. ROSE.

435. **Animal Behavior.** Seminar on modern concepts, problems, and methods with special reference to vertebrates under free-living natural conditions. I; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Zoology 335, 336, 337, or 338. KENDEIGH.

445. **Advanced Ecology and Wildlife Management.** Seminar on modern techniques, concepts, and problems. I; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Zoology 345 or equivalent. KENDEIGH.

446. **Physiological Ecology.** Physiological adjustments and responses of organisms to their environment. II; 1 unit. KENDEIGH.

455. **Advanced Genetics.** The gene in heredity, development, and evolution. I; 1 unit. LUCE.

456. **Physiological Genetics.** The nature of the gene and its action in the developmental and physiological processes of the organism. II; 1 unit. LUCE.

462. **Advanced General Physiology.** Same as Physiology 462. Seminar, lectures, student reports, discussions. I or II; ½ unit. Prerequisite: Consent of instructor. PROSSER.

467. **Experimental Embryology.** II; 1 unit. Prerequisite: Zoology 433 or equivalent. ROSE.

499. **Thesis Research.** I, II; 0 to 4 units.
Work in the following fields is offered for students registered in Zoology 499:

Ecology and Taxonomy: Herpetology, SMITH; Ichthyology, SHOEMAKER; Limnology, MATTESON; Mammalogy, HOFFMEISTER; Ornithology, KENDEIGH; Wildlife Management, KENDEIGH, SHOEMAKER.

Vertebrate Anatomy: Histology, ADAMSTONE; Vertebrate Anatomy, BADER, HALL, SMITH.

Invertebrate Zoology: Helminthology, THOMAS; Invertebrate Zoology and Field Zoology, INGLE, MATTESON; Parasitology, KRUIDENIER, THOMAS; Protozoology, CORLISS.

Experimental Zoology: Cytology, ADAMSTONE; Embryology and Regeneration, ROSE; Endocrinology, HALL; Genetics and Evolution, KITZMILLER, LUCE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Seminar.** For members of the staff and graduate students. Required of all graduate students. I; no credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Hexapoecia (entomology club).

301. **General Seminar.** For members of the staff and graduate students. Required of all graduate students. II; no credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Hexapoecia (entomology club).

302. **Individual Topics.** For those who wish to study individual problems. Graduates may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. I; ½ to 1 unit. Prerequisite: Two years of zoology; approval of department. STAFF.

303. **Individual Topics.** For those who wish to study individual problems. Graduates may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. II; ½ to 1 unit. Prerequisite: Two years of zoology; approval of department. STAFF.

304. **Field and Systematic Zoology.** Collection, preservation, and identification of lower vertebrates and land and fresh water invertebrates; habits and life histories of selected forms. I; 1 unit. Prerequisite: One year of zoology or equivalent; senior standing or consent of instructor. MATTESON.

306. **Biology for Teachers.** Same as Botany 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. Note: In order to make possible out-of-town practice teaching, this course does not meet during the six-week practice teaching period. II; ¼ or ½ unit. Prerequisite: Botany 100 and Zoology 104 or 101, or a year course in general biology. FULLER, MATTESON.

318. **Protozoology.** Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. I; 1 unit. Prerequisite: One year of zoology or equivalent. CORLISS.

320. **Invertebrate Zoology.** Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. II; 1 unit. Prerequisite: Zoology 101 or 104. INGLE.

321. **Helminth Parasitology.** Worm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz, demonstrations, and problems. I; 1 unit. Prerequisite: One year of zoology or equivalent. THOMAS.

324. **Vertebrate Paleontology.** Same as Geology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. I; ½ unit. Prerequisite: Zoology 132 or Geology 102. BADER.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology: comparative anatomy, evolution and function of vertebrate organ systems, with special

emphasis on the evolution, anatomy, and function of the skeletal and nervous systems. Lectures and laboratory. II; 1 unit. Offered in 1958-1959 and in alternate years. Prerequisite: Zoology 333. HALL.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. I, II; 1 unit. Prerequisite: Zoology 132. ADAMSTONE, KRUIDENIER.

334. **Vertebrate Histology.** Study and preparation of tissues of the vertebrate body. II; ½ unit. Prerequisite: Zoology 333 or consent of instructor. ADAMSTONE.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. II; ½ unit. Prerequisite: Zoology 101 or 104. KENDEIGH.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. I; ½ unit. Offered in 1959-1960 and in alternate years. Prerequisite: Zoology 132. HOFFMEISTER.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. I; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Zoology 132. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. II; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Zoology 132. SMITH.

340. **Natural History of the Vertebrates.** Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. II; 1 unit. Prerequisite: One year of biology including Zoology 101 or 104. SHOEMAKER.

341. **Field Ecology.** Study of biotic communities, birds, and fish in the vicinity of Reelfoot Lake, Tennessee, covering six days. Students may enroll in subsequent years for additional credit by specializing in different fields of study. II; ¼ unit. Prerequisite: Zoology 304, 335, 340, or 345, or concurrent registration in any one of these courses. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. I; ½ unit. Prerequisite: Zoology 101 or 104. SHOEMAKER.

343. **Limnology.** Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. II; ½ unit. Offered in 1958-1959 and in alternate years. Prerequisite: Zoology 101, 104, or Botany 100. MATTESON.

344. **Field Study of the Vertebrates.** Study of fish, amphibia, reptiles, birds, and mammals, with special emphasis on identification and life histories. Field trips. S; 1 unit. Prerequisite: One year of biology.

345. **Animal Ecology.** Dynamics, development, and distribution of biotic communities. I; ½ to 1 unit. Prerequisite: One year of zoology. KENDEIGH.

348. **Field Ecology.** Field studies of animal and plant communities in relation to their habitats. I, II; ½ to 1 unit. Prerequisite: One year of zoology.

349. **Animal Ecology.** Dynamics, development, and distribution of biotic communities. Credit is not given for both Zoology 345 and 349. II; ½ unit. Prerequisite: Registration in Zoology 348; senior standing or consent of instructor.

351. **Genetics.** Principles of heredity. Lectures, readings, and discussions. II; ½ unit. Prerequisite: Zoology 101 or 104, or one semester of any biological science. LUCE.

352. **Genetics.** Laboratory experiments illustrating the principles of heredity, problems, and demonstrations. II; ½ unit. Prerequisite: Credit or registration in Zoology 351. KITZMILLER, LUCE.

361. **Comparative Physiology.** Same as Physiology 361. A comparison of the general physiology of different groups of animals. I; 1 unit. Prerequisite: Three semesters of animal biology; two semesters of chemistry. ANDERSON, PROSSER.

362. **Cellular Physiology.** Same as Physiology 362. A physico-chemical analysis of biological functions common to most living cells. II; 1 unit. Prerequisite: Two semesters each of biology and general physics; three semesters of chemistry. ANDERSON.

363. **Endocrinology.** Same as Physiology 363. The glands of internal secretion with special reference to the vertebrates. I (annually); II (1958-1959 and in alternate years); 1 unit. Prerequisite: One semester of elementary zoology or physiology; Zoology 334 or organic chemistry. HALL.

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Herbert O. Farber, A.M., C.P.A., Vice-President and Comptroller
Frederick Theodore Wall, Ph.D., Dean of the Graduate College

Executive Committee of the Graduate College

1960-1961

Frederick Theodore Wall, Ph.D., Chairman; Dean of the Graduate College, Research Professor of Physical Chemistry, and Chairman of the University Research Board

Edward Hutchins Davidson, Ph.D., Professor of English

Harry George Drickamer, Ph.D., Professor of Chemical Engineering and of Physical Chemistry

Norman Arthur Graebner, Ph.D., Professor of History and Chairman of the Department of History

Ralph Early Grim, Ph.D., Research Professor of Geology

Donald Renwick Hodgman, Ph.D., Associate Professor of Economics

Lloyd Girton Humphreys, Ph.D., Professor of Psychology and Head of the Department of Psychology

Samuel Alexander Kirk, Ph.D., Professor of Education and Director of the Institute for Research on Exceptional Children

Andrew Vladimir Nalbandov, Ph.D., Professor of Animal Physiology

Milan Vaclav Novak, Ph.D., M.D., D.Sc., Professor of Microbiology, Head of the Department of Microbiology, and Associate Dean of the Graduate College for the Chicago Professional Colleges

Ralph Brazleton Peck, C.E., D.C.E., Professor of Foundation Engineering

James R. Shipley, A.M., Professor of Art and Head of the Department of Art

William Hutchinson Shoemaker, Ph.D., Professor of Spanish and Italian and Head of the Department of Spanish and Italian

Charles Pence Slichter, Ph.D., Professor of Physics

B. Othanel Smith, Ph.D., Professor of Education

J. Nelson Young, B.S., LL.B., C.P.A., Professor of Law

Calendar

SUMMER SESSION, 1960

June 20, Monday	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 20.)
June 21, Tuesday	Instruction begins.
July 1, Friday	Applications to take French examination on July 15 will not be accepted in Graduate College Office after this date.
July 4, Monday	Independence Day. No classes.
July 8, Friday	Applications to take German examination on July 22 will not be accepted in Graduate College Office after this date.
July 15, Friday evening	French examination.
July 22, Friday evening	German examination.
July 25, Monday	Latest date for dropping a course without grade of E.
Aug. 12, Fri.—Aug. 13, Sat	Summer session examinations.
August 12, Friday	No names will be added to the August graduation list after this date.
August 15, Monday	Latest date for candidates for the master's degree in August to deposit theses.
September 9, Friday	Latest date for candidates for Ph.D. degree in October to submit theses and abstracts to Graduate College for approval of format.
September 23, Friday	Latest date to file application for the master's degree in October.
September 23, Friday	Latest date for candidates for the master's degree in October to deposit theses.
September 24, Saturday	Latest date for finals for Ph.D. degree in October.
September 30, Friday	Latest date for candidates for Ph.D. degree in October to deposit theses and abstracts.

FIRST SEMESTER, 1960-1961

Sept. 14, Wed.—Sept. 17, Sat.	Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register on Saturday, September 17. There will be no registration on Saturday, September 24.
September 17, Saturday	Latest date for registration of former students without payment of late registration fee.
September 19, Monday	Instruction begins.
September 30, Friday	Applications to take French examination on October 14 will not be accepted in Graduate College Office after this date.
October 7, Friday	Applications to take German examination on October 21 will not be accepted in Graduate College Office after this date.
October 14, Friday evening	French examination.
October 21, Friday evening	German examination.
October 31, Monday	Latest date for adding a course to program.
November 5, Saturday	Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to the "third" year.
November 18, Friday	Applications to take French examination on December 2 will not be accepted in Graduate College Office after this date.
November 23, Wednesday	Applications to take German examination on December 9 will not be accepted in Graduate College Office after this date.
November 23, Wednesday, 1 p.m.	Thanksgiving vacation begins.
November 28, Monday, 8 a.m.	Thanksgiving vacation ends.
December 2, Friday evening	French examination.
December 9, Friday evening	German examination.
December 12, Monday	Latest date for dropping a course without grade of E.
December 17, Saturday, 1 p.m.	Christmas vacation begins.
January 3, Tuesday, 1 p.m.	Christmas vacation ends.
January 13, Friday	Latest date for candidates for Ph.D. degree in February to submit theses and abstracts to Graduate College Office for approval of format.
January 19, Thursday	Study day. Classes dismissed.
Jan. 20, Fri.—Jan. 28, Sat.	Semester examinations.

January 20, Friday	No names will be added to the February graduation list after this date.
January 20, Friday	Latest date for candidates for the master's degree in February to deposit theses.
January 28, Saturday	Latest date for finals for Ph.D. degree in February.
February 1, Wednesday	Latest date for candidates for Ph.D. degree in February to deposit theses and abstracts.

SECOND SEMESTER, 1960-1961

Feb. 6, Mon.—Feb. 8, Wed.	Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register on Saturday morning, February 4. There will be no registration on Saturday, February 11.)
February 8, Wednesday	Latest date for registration of former students without payment of the late registration fee.
February 9, Thursday	Instruction begins.
February 15, Wednesday	Latest date for applications for fellowships for 1961-1962.
February 17, Friday	Applications to take French examination on March 3 will not be accepted in Graduate College Office after this date.
February 24, Friday	Applications to take German examination on March 10 will not be accepted in Graduate College Office after this date.
March 3, Friday evening	French examination.
March 10, Friday evening	German examination.
March 18, Saturday	Latest date for preliminary examination for Ph.D. degree if thesis credit earned during the semester is to apply to the "third" year.
March 20, Monday	Latest date for adding a course to program.
March 25, Saturday, 1 p.m.	Spring vacation begins.
April 3, Monday, 1 p.m.	Spring vacation ends.
April 14, Friday	Applications to take French examination on April 28 will not be accepted in Graduate College Office after this date.
April 21, Friday	Applications to take German examination on May 5 will not be accepted in Graduate College Office after this date.
April 24, Monday	Latest date for dropping a course without grade of E.

April 28, Friday evening	French examination.
May 5, Friday	Honors Day. Classes dismissed at noon.
May 5, Friday evening	German examination.
May 19, Friday	Latest date for candidates for Ph.D. degree in June to submit theses and abstracts to Graduate College Office for approval of format.
May 26, Friday	No names will be added to the June graduation list after this date.
May 26, Friday	Latest date for candidates for the master's degree in June to deposit theses.
May 30, Tuesday	Memorial Day. No examinations.
May 31, Wed.—June 8, Thurs.	Semester examinations.
June 2, Friday	Latest date for finals for Ph.D. degree in June.
June 7, Wednesday	Latest date for candidates for Ph.D. degree in June to deposit theses and abstracts.
June 17, Saturday	Commencement exercises.

SUMMER SESSION, 1961

June 19, Monday	Graduate registration. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 19.)
June 20, Tuesday	Instruction begins.
June 30, Friday	Applications to take French examination on July 14 will not be accepted in Graduate College Office after this date.
July 4, Tuesday	Independence Day. No classes.
July 7, Friday	Applications to take German examination on July 21 will not be accepted in Graduate College Office after this date.
July 14, Friday evening	French examination.
July 21, Friday evening	German examination.
July 24, Monday	Latest date for dropping a course without grade of E.
Aug. 11, Fri.—Aug. 12, Sat.	Summer session examinations.
August 11, Friday	No names will be added to the August graduation list after this date.
August 14, Monday	Latest date for candidates for the master's degree in August to deposit theses.

September 8, Friday	Latest date for candidates for Ph.D. degree in October to submit theses and abstracts to Graduate College Office for approval of format.
September 22, Friday	Latest date to file application for the master's degree in October.
September 22, Friday	Latest date for candidates for the master's degree in October to deposit theses.
September 23, Saturday	Latest date for finals for Ph.D. degree in October.
September 29, Friday	Latest date for candidates for Ph.D. degree in October to deposit theses and abstracts.

NOTES

Candidates for master's degrees must submit thesis titles to the Graduate College six weeks prior to graduation date.

The two language examinations required for the Ph.D. should be passed as early as possible and must be passed in the term preceding the preliminary examination or at least two months prior to that examination.

The general thesis topic is made known to the doctoral committee at the time of the preliminary examination. The final thesis title should be submitted to the Graduate College about three months prior to the conferring of the degree.

Executive Officers of Fields of Instruction

Accountancy	Cecil Adolph Moyer
*Advertising	Charles H. Sandage
Aeronautical Engineering	Henry Sheldon Stillwell
Agricultural Economics	Harold G. Halcrow
*Agricultural Engineering	Frank Bristol Lanham
Agronomy	Morell Belote Russell
Animal Science	O. B. Ross
Anthropology	Joseph B. Casagrande
*Architecture	Alan Kemp Laing
*Art	James R. Shipley
Astronomy	George Cunliffe McVittie
*Biological Sciences	Leigh Edward Chadwick
Botany	Wilson Nichols Stewart
Business	Harvey Wilborn Huegy
Ceramic Engineering	Andrew Irving Andrews
Chemistry and Chemical Engineering	Herbert Edmund Carter
*City Planning and Landscape Architecture	Louis Bemis Wetmore
Civil Engineering	Nathan Mortimore Newmark
Classics	John Lewis Heller
*Commercial Teaching	Arnold Clarion Condon
Communications	Dallas Walker Smythe
Dairy Science	Glenn Wade Salisbury
*Dance	Margaret Erlanger
Economics	John Fred Bell
Education	Charles Moore Allen
Electrical Engineering	Edward Conrad Jordan
English	Robert Wentworth Rogers
Entomology	Leigh Edward Chadwick
Finance	Paul Marion Van Arsdell
Food Technology	Reid Thompson Milner
French	Charles Anthony Knudson
Geography	Joseph Albert Russell
Geology	George Willard White
German	Frank Graham Banta
*Health and Safety Education	Howard Stanley Hoyman

* Give work for master's degrees only.

History	Chester G. Starr
Home Economics	Janice Minerva Smith
Horticulture	Charles John Birkeland
Italian	William Hutchinson Shoemaker
*Journalism	Jay Walbourne Jensen
*Labor and Industrial Relations	Martin Wagner
Law	Russell Neil Sullivan
Library Science	Robert Bingham Downs
*Management	Stewart Yarwood McMullen
*Marketing	Harvey Wilborn Huegy
Mathematics	Mahlon Marsh Day
Mechanical and Industrial Engineering	Norman Alwyn Parker
Microbiology	Halvor Orin Halvorson
Mining and Metallurgical Engineering	Thomas Albert Read
Music	Duane Adams Branigan
*Nuclear Engineering	Marvin Eugene Wyman
Philosophy	Dilman Walter Gotshalk
Physical Education	Seward Charle Staley
*Physical Sciences	Theodore L. Brown
Physics	Gerald Marks Almy
Physiology	Robert Eugene Johnson
Plant Pathology	Wayne Melville Bever
Political Science	Clyde Frank Snider
Psychology	Lloyd G. Humphreys
*Radio and Television	Hubert Victor Cordier
*Recreation	Charles K. Brightbill
*Social Sciences	Joseph Ward Swain
*Social Work	Marietta Stevenson
Sociology	Louis Schneider
Spanish	William Hutchinson Shoemaker
Speech	Karl Richards Wallace
Statistics	Mahlon Marsh Day
Theoretical and Applied Mechanics	Thomas James Dolan
Veterinary Medical Science	Carl Alfred Brandly
Zoology	James Blaine Kitzmiller

* Give work for master's degrees only.

The Graduate College

Graduate instruction is offered on the Urbana campus of the University of Illinois in the areas listed on pages 3 and 4 and described in more detail under the departmental listings. In addition, graduate work in the medical and dental sciences and in pharmacy is offered at the Chicago Professional Colleges. Inquiries concerning graduate work in Chicago should be directed to Dr. Milan V. Novak, Associate Dean of the Graduate College for the Chicago Professional Colleges, 808 South Wood Street, Chicago 12, Illinois.

The general requirements for admission and the degree requirements established by the Graduate College are described in this introductory section. All candidates for degrees must meet these requirements as well as those specified by the major department in the departmental listings. The degree candidate is held responsible for knowing both the general requirements of the Graduate College and the more specific ones pertaining to his major area. Every student should obtain a Graduate College catalog, a departmental bulletin, if one is issued, and a Graduate College calendar. The latter is printed each year and may be obtained at the Graduate College Office.

Admission

Procedure. A prospective student should file his application for admission at least six weeks before he expects to register. Admission forms may be obtained from the Office of Admissions and Records, 100a Administration Building, or from the Graduate College. Foreign students should request admission by letter (see page 16).

An applicant will be favorably considered for admission to the Graduate College if he fulfills the following conditions: (1) he is a graduate of an institution awarding a baccalaureate degree comparable to that granted by the University of Illinois; (2) he is adequately prepared for advanced study as demonstrated by his previous program of study and his scholastic record; and (3) he is recommended for admission by the major department and the Dean of the Graduate College.

The prerequisites considered necessary for advanced work in the various fields of specialization are listed in the corresponding departmental sections of this catalog. Also listed are the scholastic grade-point averages which must be met before an application for admission is con-

sidered. The scholastic average is computed on the basis of the last sixty semester hours of work completed. Applicants with an average less than 3.5 are advised not to apply. (In computing the average, A = 5.0; B = 4.0; etc.)

A department's recommendation with respect to the admission of an applicant is based not only on the scholastic average but on other factors relevant to the total graduate program. For this reason, not all who meet the scholastic requirements may be admitted.

Graduate Study by Seniors at the University of Illinois. A senior who has been in residence for at least two semesters and who is within five semester hours of his bachelor's degree may be admitted to the Graduate College if his grade-point average for the last sixty hours is at least 4.0. Seniors who meet these requirements and who wish to apply should submit an application for admission to the Office of Admissions and Records together with a letter from the dean of the undergraduate college specifying the hours needed to secure the bachelor's degree. If admitted to the Graduate College, the student must carry as miscellaneous course work the hours needed to complete the requirements for the first degree; in addition, he will register for courses to be credited toward an advanced degree.

A senior who is within ten hours of the bachelor's degree may register in graduate courses for graduate credit if his grade-point average is that specified above and if he secures the approval of the head of the major department and the instructors concerned. In all such cases, the program card must be signed by the Dean of the Graduate College before registration is completed. Graduate credit so earned does not count toward an advanced degree unless the student qualifies for admission with full standing at the close of the session and enrolls as a graduate student during the following regular semester.

Readmission. A former student who has not registered for one or more semesters must file an application for readmission. This form should be submitted to the Office of Admissions and Records several weeks before the beginning of the term in which he expects to register.

Students from Abroad. A student from abroad who wishes to be admitted to graduate study at the University of Illinois should write to the Office of Admissions and Records, 100a Administration Building, Urbana, Illinois, enclosing copies of his academic records certified by the educational institutions previously attended. A student whose native tongue is not English is required to take an examination in English before registration. If his command of the language is not adequate, he must take and pass certain courses in the study of English as a foreign language.

In such cases, the student must expect to spend an extra semester or summer session on his degree program.

The Director, Office of Foreign Students, 152 Administration Building (West), assists students from abroad with problems involving passports, visas, and other matters.

Program of Studies

Advisers. Every graduate student must have an adviser in the department in which he is a degree candidate. The adviser's primary duty is to assist the student in planning a program of graduate work which fits the needs of the student and satisfies departmental and Graduate College requirements. A new graduate student should go to his major department to discuss the selection of an adviser.

Unit Credit for Courses. Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five. The normal program for an eight-week summer term is two units; the maximum permissible is two and one-half units.

Work Completed Elsewhere. A candidate for the doctorate, who has received a master's degree from a recognized institution, need not submit a petition to receive credit for such work. It is considered the equivalent of eight units. However, if such credit is used in partial fulfillment of the requirements for the doctorate, he will be examined on the content of the courses involved at the time of the preliminary examination.

A graduate student who has done graduate work in other approved institutions for which no degree was conferred may petition to obtain credit toward an advanced degree by passing examinations in this work. Admission to such examinations requires the prior approval of the departments concerned and of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement for the master's degree.

If it is recommended in advance by the major department, the Graduate College may permit a student to register for work at a laboratory elsewhere offering facilities not available at Urbana. It is understood that such work will be accepted for graduate credit if completed satisfactorily. The amount of credit to be recorded is recommended by the major department after receipt of the transcript and examination of the student.

Auditing Privileges. A graduate student or a person not registered

in the University of Illinois is permitted to attend classes (other than laboratory courses) as an auditor, provided a form bearing the approval of the instructor and the Dean of the Graduate College is filed with the Recorder. A student should not enter on his program card any courses which he plans to attend as an auditor.

Extramural Courses. Graduate courses in a few areas of study are offered at various centers throughout the state. A student who is employed full time may not register for more than one unit of extramural course work in any one semester nor more than one unit in any combination of extramural and campus courses.

Extramural course work is not work in residence and credit earned in such courses can be applied to an advanced degree only under the following circumstances: (1) if the courses are approved in advance by the adviser and constitute part of a well-integrated program, and (2) if the total extramural credit does not exceed two units (the Ed.M. and the Advanced Certificate excepted). Credit earned in extramural courses is not accepted in partial fulfillment of the requirements for the second stage of a doctoral program.

Correspondence Courses. Credit earned in correspondence courses can not be applied to an advanced degree. However, certain prerequisites can be fulfilled or deficiencies removed through correspondence work. A catalog of correspondence courses offered by the University of Illinois may be obtained from the Division of University Extension, Correspondence Courses, 247 Illini Hall, Champaign, Illinois.

Grades. Grades are recorded by letters as follows: for courses, A (excellent), B, C, D, E (failure); for thesis research, S and U (satisfactory and unsatisfactory). Any student who receives as much as two but less than three units of grade below B must replace them with additional units of A or B grade to qualify for an advanced degree. Three units of a grade below B disqualify a student as a candidate for a degree in the Graduate College.

Residence. Each degree candidate must spend a certain period of time in "residence." Residence is realized when a student lives in the community, or its immediate surroundings, and devotes an appreciable fraction of his time to graduate studies. A student who is regularly employed outside the Champaign-Urbana community is not considered to be in residence even though he is registered in a campus course.

Time Limit for Advanced Degrees.

(1) A candidate for the master's degree must complete all requirements for the degree within five calendar years after his first registration in the Graduate College.

(2) A candidate for the doctor's degree must complete all requirements for this degree within seven calendar years after his first registration in the Graduate College, except as noted in paragraph 3 below.

(3) A candidate for the doctorate who has received a master's degree elsewhere must complete all requirements for the degree within five years after his first registration in the Graduate College. This same regulation applies to the candidate who has received his master's degree from the University of Illinois and whose studies were interrupted immediately thereafter, provided not more than the minimum number of units required for the master's degree are applied to the doctorate.

(4) In general, the transfer of graduate credit from other institutions under circumstances not specifically defined above shall be considered a basis for proportionate reduction of the time allowed for earning a degree.

Graduate Programs for Employed Students. A student who is employed can not expect to complete his academic work as promptly as one who devotes full time to his academic program. The academic work carried by assistants and others on the University staff is limited by statute, and no deviation is permitted without compelling reasons. Those employed outside the University are expected to reduce their programs of work in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Nature of Appointment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1½ units
Two-thirds time	2¼ units	1½ units
One-half time	3 units	1¾ units
One-third time	3½ units	2 units
One-fourth time	4 units	2 units

Conferring of Degrees. Advanced degrees are conferred in February, June, August, and October, except that the doctorate is not awarded in August.

Petitions. The normal procedures and requirements of the Graduate College are indicated in this catalog, but these may be modified occasionally for justifiable reasons. A student may petition to the Dean of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms may be secured at the Graduate College Office.

The Master's Degree

Master's degrees are offered in the fields indicated on pages 12 and 13. Unless otherwise specified in the departmental listings, the credit requirement for this degree is at least eight units of satisfactory work. It is expected that three of the eight units will be in courses numbered in the 400 series, and that two of these three will be in the major field. The teacher-training curricula and certain special programs are exempt from this regulation.

Residence. A candidate must spend at least two semesters, or the equivalent, in residence and must earn at least half of the required units in residence.

Majors and Minors. A candidate for a master's degree may do all his work in one field, or he may select a major and one minor, or a major and two minors. For a master's degree a major requires a minimum of four units of work.

Foreign Language. During the first year of graduate study a student who plans to become a candidate for the Doctor of Philosophy degree should qualify in at least one of the languages required by the Graduate College.

Thesis. If a student elects to prepare a master's thesis or is required to do so by his department, he should file the subject of the thesis at the Graduate College Office at least six weeks prior to graduation. No more than three units of thesis credit may be included in an eight-unit program. Credit in thesis research can not be applied to a degree unless a thesis is submitted.

For specific instructions with reference to the preparation and form of the thesis, the student should obtain at the Graduate College Office a copy of the leaflet "Instructions for Preparation of Theses."

Teacher-Education Programs. Programs leading to the master's degree for teachers in various fields are available for students who have satisfactorily completed the four-year undergraduate teacher-training program, or the equivalent. Students who have not met all of the requirements of a four-year undergraduate curriculum but who wish to take the fifth year of work for a master's degree may register in an approved program with the permission of the adviser and of the Coordinator of Teacher Education. Two units may be completed in extramural graduate courses. Programs for teachers are offered in the following areas, and special requirements for each are given on the page indicated:

Agricultural Education — page 45
Art — page 61
Biological Sciences and General Science — page 65
Chemistry — page 83
Commercial Teaching — page 76
Education of the Deaf — page 121
Education of Mentally Handicapped Children — page 121
English — page 143
French — page 158
Geography — page 162
German — page 169
Health Education — page 171
Home Economics — page 178
Latin — page 104
Mathematics — page 205
Mathematics and the Physical Sciences — page 205
Music — page 227
Physical Education — page 241
Physical Sciences — page 243
Physics — page 244
Social Studies — page 275
Spanish — page 286
Speech — page 289
Speech Correction — page 290

The Degree of Doctor of Philosophy

The degree of Doctor of Philosophy is offered in the fields indicated on pages 12 and 13. The general requirements for the degree are described below and any special departmental requirements are given in the departmental listings. For information concerning the degrees of Doctor of Education, Doctor of Education in Music Education, Doctor of Musical Arts, Doctor of the Science of Law, and Doctor of Business Administration, see the appropriate departmental listings.

Residence. A candidate must spend two years in residence, including two successive semesters after the master's degree or the equivalent, and must complete at least sixteen units in residence.

Major and Minor Subjects. A candidate is required to declare a major field of study and one minor (requiring four units) or two minors (requiring two units each). If he elects two minors, only one of them may be a division of the major department or field; a full minor must be entirely outside the department offering the major. The requirements for a minor in any field should be checked with the department concerned.

Language Requirements. A candidate is required to demonstrate ability to read two of the following languages: French, German, or Russian. The language requirement should be satisfied early in the doctoral program, in any event not later than two months prior to the preliminary examination, or during the semester (or summer session) preceding admission to the preliminary examination. A student may satisfy the language requirement by (a) direct examination or by (b) obtaining grades of A or B in French, German, or Russian 401. However, students majoring in English, history, and philosophy must satisfy the language requirement by direct examination. Certification of proficiency in foreign languages is not accepted from other colleges or universities.

Doctoral Committee. A permanent doctoral committee to conduct the preliminary and final examinations is appointed by the Dean of the Graduate College upon recommendation of the executive officer of the department in which the student is doing his major work.

Preliminary Examination. A candidate for the doctor's degree must pass a preliminary oral examination to test his knowledge of his major and minor fields of study. He is not admitted to the examination before (1) he has fulfilled the language requirement; (2) he has satisfactorily completed sixteen units of graduate work; and (3) the departments of his major and minor fields of study consider, through written examination or otherwise, that he has adequate preparation.

Final Examination. When the thesis has been completed, the candidate is admitted to the final examination upon recommendation of the major department. A student who has failed to maintain high standards of scholarship and research is refused admission to the final examination. Although the examination is concerned primarily with the research accomplished by the student as described in his thesis, it may extend over the candidate's whole field of study.

Thesis. The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the production of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination. The student should register for at least eight units of research credit while preparing his dissertation. Moreover, after passing his preliminary examination, he must register each semester (excluding summer sessions) until such time as he passes the final examination irrespective of how many units he may have earned.

Directions regarding thesis form and style are given in the leaflet "Instructions for Preparation of Theses," which may be obtained in the Graduate College Office. The candidate must submit to the Graduate College, no later than the date specified in the current Calendar, the original and first carbon copy (or two copies reproduced by an approved method) of his thesis and one typewritten copy of an abstract of not more than six hundred words.

Each candidate who passes the final examination must pay a $25.00 microfilm fee. This provides for (1) microfilming of the complete thesis, with one copy deposited in the University of Illinois Library, and (2) publication of the abstract in *Dissertation Abstracts.*

Financial Assistance

Various types of financial assistance are available each year to promising graduate students in any field in which the Graduate College offers an advanced degree. Detailed information about the qualifications and application procedures for these awards is given in the brochure "Financial Aid for Graduate Students, 1960-62," a copy of which may be obtained by writing to the Graduate College or to any of the graduate departments.

The principal kinds of awards are as follows:

University Fellowships. University Fellowships are awarded on the basis of an all-University competition and are unrestricted as to the student's field of graduate study. Each provides a stipend of not less than $1,500 for the academic year with exemption from tuition and all fees for the academic year and for the following eight-week summer session. University Fellows must carry a full program, four units or the equivalent.

University Teaching Fellowships. These appointments provide a tax-free fellowship stipend of $1,000 plus a taxable salary of $1,000 for service as a quarter-time teaching assistant, with the usual exemption from tuition and incidental fees. University Teaching Fellows must also carry full programs of graduate study.

Industrial, Endowed, Special Fellowships, and Teaching Fellowships, and Traineeships. Various industrial firms, foundations, government agencies, and private individuals have generously donated funds to support a number of special fellowships and teaching fellowships for graduate students at the University of Illinois. The stipends and supplemental allowances of these fellowships are not uniform, and most of them are restricted to students in particular areas of study. Brief descriptions of the names, donors, fields, and other conditions pertaining to each are presented in the brochure referred to above.

National Science Foundation Cooperative Graduate Fellowships. These fellowships are financed by the National Science Foundation, but are administered with the cooperation of the participating universities, including the University of Illinois. They are restricted to United States citizens who are graduate students in the mathematical, physical, medical, biological, and engineering sciences and in certain other fields regarded as employing scientific methods. Each carries a stipend of $2,200 for twelve months or $1,650 for nine months, plus tuition and fees. An applicant for a cooperative fellowship must send his application to the university at which he proposes to pursue his graduate studies,

not directly to the National Science Foundation. Anyone who wishes to apply may secure application materials from the Graduate College or from the National Science Foundation.

Assistantships. The usual academic assistantship appointment, which provides teaching or research experience, is on a half-time basis at a salary of $1,900 for the academic year. Students holding academic employment calling for more than 62.5 per cent-time service are required to pay tuition and fees. Those whose appointments call for a lesser percentage of time receive exemption from tuition and all fees except the hospital-medical-surgical insurance fee. Assistants must carry a reduced program of study, as shown on page 19.

Part-time appointments as student residence hall counselors are also available. They provide cash stipends plus room and board and the usual tuition and fee exemptions. For further information, women may write to the Dean of Women, 100 English Building; men should write to the Supervisor of Counseling, Men's Residence Halls.

Tuition and Fee Waivers. These awards provide exemption from tuition and all fees except the hospital-medical-surgical insurance fee for the academic year and the following summer session. In general, students holding these awards must be in residence and must register for at least three units each semester during the academic year. They may, however, accept part-time or incidental employment not to exceed twenty hours a week either within or outside the University.

Application materials with instructions can be obtained from the Graduate College or from any graduate department. Except for the National Science Foundation Cooperative Graduate Fellowships, only one application form is needed to apply for any of the types of financial aid listed above. To be considered for a University Fellowship or Teaching Fellowship for the following academic year, an application must be returned before February 15. Applications for tuition and fee waivers and assistantships are accepted after that date, but applicants for such appointments are strongly urged to submit their applications as early as possible since many departments offer assistantships at the same time they consider applications for fellowships.

All applicants for Fellowships and Teaching Fellowships are informed of the disposition of their applications on or about April 1. Successful applicants are expected to accept or decline by April 15.

The University of Illinois adheres to the following resolution adopted by the members of the Association of American Universities and a number of other graduate schools of North America:

"In every case in which a graduate assistantship, scholarship, or

fellowship for the next academic year is offered to an actual or a prospective graduate student, the student, if he indicates his acceptance before April 15, will still have complete freedom to reconsider his acceptance and to accept another fellowship, scholarship, or graduate assistantship. He has committed himself, however, not to resign an appointment after this date unless he is formally released from it."

Loan Funds. Loan funds have been established for the benefit of worthy students in the University who need financial assistance. The University of Illinois also participates in the Student Loan Program under the National Defense Education Act. Application blanks for both types of loans may be secured from the Business Office, 101 Administration Building (East), Urbana, Illinois.

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 3,200,000 volumes, all but about 228,000 of them located in Urbana. The remainder are held by the Library of Medical Sciences in Chicago and the Undergraduate Division in Chicago.

In addition to the figures for cataloged volumes cited above, the University Library contains approximately 350,000 pamphlets, 219,000 maps, and 52,000 music scores and parts. More than 15,600 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archaeology; sixteenth- and seventeenth-century English literature, especially the Milton-Shakespeare period; nineteenth-century English literature, American humor and folklore; French, Italian, and Spanish literature; German literature of the sixteenth and seventeenth centuries; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

In the social sciences, the Library's holdings are significant for western United States history, Abraham Lincoln and the Civil War, Latin-American history of the Revolutionary period, Italian history, medieval and modern European history, German history for 1830-1900, Irish history, international law and relations, political science, law, economics, labor and industrial relations, and education.

For science and technology, collections of high rank are held in mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering, and agriculture.

The Library's bibliographical facilities comprise a union catalog of more than 3,000,000 cards, representing titles owned by about two dozen major American and foreign libraries; printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained. Following are the principal separately administered collections in the central library building: Classics; Commerce, Sociology, and Social Work; Education, Philosophy, and Psychology; English; Germanic and Romance Languages; History and Political Science; Library Science; Map and Geography; and Physical Education.

Elsewhere on the campus are departmental libraries for the following fields: Agriculture, Architecture and Fine Arts, Biology, Chemistry, City Planning, Engineering, Geology, Home Economics, Journalism, Landscape Architecture, Law, Mathematics, Music, Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine.

Further facilities available for graduate students are the general bookstacks, housing about 2,000,000 volumes, and over 200 carrels in the bookstacks, assigned to individuals engaged in prolonged study and research. Interlibrary loan service from other institutions is provided for those engaged in research for dissertations.

Special Laboratory Facilities

Digital Computer Laboratory. The Digital Computer Laboratory offers instruction in courses and supervision of theses for individuals specializing in the design and use of the digital computing machinery which is now of such importance in research work in modern technology. The Laboratory possesses the Illiac, a high-speed general-purpose computing machine which was built at the University of Illinois, and is available to the members of the staff of the University of Illinois for solving their scientific problems. This computational facility of the Laboratory was recently supplemented by an IBM 650 computer. This expansion is due in part to the fact that the work of the Laboratory and the University in the area of data processing is expanding. Members of the staff who are engaged in computer research regularly offer ten courses: Mathematics 295, 387, 395, and 457, Mathematics-Electrical Engineering 294, 391, 392, 393, and 394, and Mathematics-Agronomy

365. There is also a weekly seminar (no credit). Descriptions of these courses are given under the appropriate department headings.

Although no advanced degree is offered by the Digital Computer Laboratory, candidates for advanced degrees in electrical engineering, mathematics, or physics who are interested in this area of study may engage in thesis work under the supervision of one of the staff members in the Laboratory.

The Laboratory is actively engaged in the construction of a very high-speed computer (between 100 and 200 times faster than Illiac) of its own design. Construction is presently underway. This is in addition to the research being carried out in Boolean algebra of switching circuits, applied mathematics, computer circuits, and high-speed memories. Requests for additional information concerning the work in the Laboratory and applications for assistantships should be directed to the head of the Digital Computer Laboratory.

Electron Microscope Laboratory. The Electron Microscope Laboratory is devoted to research work in behalf of all University departments. It is equipped with four different types of RCA electron microscopes, an EMC (console type), an EMT (table model with permanent magnet lens), an EMU-2, an EMU-3 model, and an electron diffraction unit. The first three microscopes are permanently located in an air-conditioned laboratory and are for general student and service work. The EMU-3 is located in a special laboratory and is reserved for the exclusive use of faculty and staff investigators. Seminar and laboratory courses in electron microscopy are offered for the purpose of training qualified graduate students from all departments in the technique. The laboratory is under the direction of a qualified electron micrographer.

Physical Environment Unit. The facilities of the Physical Environment Unit include rooms and an altitude chamber, in which ranges of temperature, humidity, and pressure can be controlled, and basic medical and physiological instruments. They are available for use by any department or division of the University needing controlled environmental conditions for special research or instructional work. Although primarily designed for studies with human subjects and animals, the facilities can also be used for limited engineering and physical science activities.

Research assistantships, while not available in the Physical Environment Unit, are available in some of the departments interested in the effects of environment on people and animals. Inquiries regarding such assistantships should be sent to the department offering the specific work in which the student is interested.

Radiocarbon Laboratory. The Radiocarbon Laboratory, an all-university facility maintained and directed by a permanent staff, conducts research on chemical, physical, and biological problems by use of the tracer technique with carbon-14. Modern radiochemical equipment for the synthesis, degradation, isolation, and assay of radioactive carbon compounds is available.

A carbon-14 course, Chemistry 496 and Animal Nutrition 496, introducing radioactive carbon as a unique and potent tool of investigation and emphasizing experimental techniques, is conducted by the staff one semester each year and is a prerequisite for student research in the Laboratory.

Fees and Expenses

Students registering for resident work pay fees each semester or summer session according to the following schedules:

SEMESTER TUITION AND FEES

(Payable in full when the student registers unless the installment plan is elected)

Tuition Fee (except those holding scholarships)

	Regular Schedule (Over two units)	*Reduced Schedule (Two units or less)*
Residents of Illinois	$ 75.00	$24.00 per unit
Nonresidents of Illinois	250.00	80.00 per unit
Laboratory, Library, and Supply Fee	12.00	6.00
Hospital-Medical-Surgical Insurance Fee	8.00	8.00
All students, including persons on part-time appointment on the University staff or the staffs of the allied surveys or laboratories, are subject to this fee. Students who present evidence of participation in any other group insurance system providing the same benefits as those covered by the University fee may petition through the University insurance office for a refund of this fee. *Students registered for one unit or less are exempt from this fee upon application to the University Insurance Office.*		
Illini Union Service Charge	10.00	10.00
Students registered for one unit or less, holders of graduate tuition and fee waivers, and University staff members are exempt from this fee.		

SUMMER SESSION TUITION AND FEES

(Payable in full when the student registers unless the installment plan is elected)

Tuition Fee (except those holding scholarships)

	Regular Schedule (Over one unit)	*Reduced Schedule (One unit or less)*
Residents of Illinois	$ 37.50	$24.00 per unit
Nonresidents of Illinois	125.00	80.00 per unit
Laboratory, Library, and Supply Fee	6.00	3.00
Hospital-Medical-Surgical Insurance Fee	4.00	4.00
Students registered for one-half unit or less are exempt from this fee upon application to the University Insurance Office.		
Illini Union Service Charge	5.00	5.00
Students registered for one-half unit or less and University staff members are exempt from this fee.		

SPECIAL FEES

Late Registration Fee ..... $ 5.00

Former students, whether on appointment or not, who register after the regular registration days in either semester are subject to this fee.

Change of Program Fee 1.00

This fee is charged for every change slip issued at the request of the student after the completion of registration.

"In Absentia" Registration

Students enrolled for credit in thesis work for the master's or doctor's degree on leave of absence pay only the regular tuition fee, resident or nonresident, as listed above.

Registration for 0 Credit

Candidates for the doctor's degree, resident or nonresident, enrolled in thesis-research work for 0 credit pay each semester a flat fee of... 6.00
($4.00 each term at the Chicago Professional Colleges)

Listener's Fee 10.00

Persons who attend classes as listeners, except those on University appointment and students registered for a full schedule, pay this fee for each course.

Flight-Training Fee 300.00

Students taking flight-training pay this materials and supply fee for each flight-training course.

Extramural Courses

Credit courses

Tuition fee for each unit 24.00
Laboratory, Library, and Supply Fee 6.00

Noncredit courses

Registration fee for a one-hour course..... 12.00
Two hours, $18.00; three hours, $24.00.

Off-Campus Courses (field courses and social work courses in Chicago)

Students pay the regular tuition fee, the laboratory, library, and supply fee, and the hospital-medical-surgical insurance fee. Students in social work courses in Chicago registered for more than one unit of graduate credit in any semester pay an Illini Union service charge of $7.50. Students in field courses are exempt from the Illini Union service charge.

Recreational Sports Fee

Visitors pay each semester..... 12.00
For the summer term, $6.00.

Wives or husbands of students and members of the faculty pay each semester..... 6.00
For the summer term, $3.00.

Transcript Fee 1.00

Each student who has paid all his University fees in entitled to receive, without charge, one transcript of his record. For each additional transcript the fee is $1.00.

Installment Fee 2.00

Students electing the installment plan for payment of tuition and fees must pay this service charge. An additional service charge of $2.00 is assessed if the flight instruction fee is paid on the installment plan.

EXEMPTION FROM FEES

The following graduate students may register in University courses for which they are eligible for admission without payment of the tuition fee and the laboratory, library, and supply fee:

(1) Academic employees of the University, or of allied surveys and laboratories located on the Urbana-Champaign campus, provided their official appointments call for not more than 62.5 per cent of full-time services for a minimum of four months during the semester in which exemption is desired.

(2) Holders of tuition and fee waivers awarded by the Graduate College.

(3) Permanent nonacademic employees of the University, or of the allied surveys and laboratories located on the Urbana-Champaign campus, provided their annual salary is less than the minimum salary established for full-time assistants ($3,800.00 for nine months; $4,650.00 for twelve months), and provided that their official appointments call for a minimum of four months of service during the semester in which exemption is desired.

(4) Permanent nonacademic employees, without regard to salary, who register in any regular University course at the request of the employee's department, with the concurrence of the Director of Nonacademic Personnel, for the improvement of the employee's present work.

(5) Permanent nonacademic employees who register in any special course

looking toward improving University service organized at the request of the Director of Nonacademic Personnel in cooperation with the teaching staff, the employee, and his department.

Graduate students holding appointments during the second semester of an academic year either as employees or fellows, and for whom tuition or fees have been provided through exemption, waiver, or cash payment by an outside agency, are exempt from the payment of the same kinds of tuition and fees for the summer session immediately following, provided they hold no appointments during the summer session. Graduate students holding summer session appointments as fellows or employees requiring at least seven weeks of service are subject to such tuition and fees as would be assessed in accordance with the principles expressed above.

Academic and nonacademic employees not subject to tuition and fees by reason of their appointments who resign from their positions before the midpoint of the semester or summer session are subject to payment of tuition and fees.

Graduate students who hold any type of University appointment, including that of fellow, may not accept additional employment from the University or any allied agency without the approval of the Dean of the Graduate College.

REFUNDS OF FEES

In case a student withdraws from the University during the first ten days of instruction in any semester, the total amount of his fees, except the hospital-medical-surgical insurance fee, is refunded. After ten days and before the middle of the semester, a rebate of one-half of the fees is made. After the middle of the semester, no rebate is allowed. In the summer term, for students registered for eight weeks, the total amount of fees paid, except the hospital-medical-surgical insurance fee, is refunded if withdrawal occurs within the first five days; one-half the amount after the first five days but within the first four weeks; and nothing after the beginning of the fifth week.

EXPENSES

Although personal expenses may vary a great deal, the following estimates indicate the average cost for students: board, $15.00 to $18.00 a week; room rent, single rooms from $25.00 to $40.00 a month; double rooms from $20.00 to $30.00 a month for each person.

Housing

The University has residence facilities for single graduate students, both men and women, and a limited number of apartments in University-owned student-staff apartment buildings. Applications for both rooms and apartments may be obtained from the Housing Division, 108 Illini Hall. In addition, the Director of Housing maintains a list of apartments and rooms available in private homes in the community.

Automobile Regulations

Graduate students who hold at least half-time teaching or research appointments, all fellows, and all who hold tuition and fee waivers, are permitted to park in the faculty-staff lots from 5:00 p.m. to 1:00 a.m. and on University and city streets at any time, subject to city regulations. Other graduate students may park at any time on city streets, subject to city regulations.

Any resident graduate student, not holding at least a half-time appointment or a fellowship or tuition and fee waiver and who regularly operates a car in the Champaign-Urbana community is assessed a fee of $15.00 a year ($7.50 a semester).

Fields of Instruction

Courses open to graduate students are of two classes. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only.

Many courses for graduate students require some measure of previous preparation. By consultation with the instructor, a student may learn whether he has had the necessary prerequisites for a particular course.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Accountancy and Master of Accounting Science.

The minimum grade-point average for admission to graduate study in accountancy is 3.5.

Degree of Master of Science. A candidate for the Master of Science degree must have had the equivalent of twenty hours of undergraduate work in accountancy and at least one course each in principles of economics and finance. Eight units are required of which at least four must be in courses numbered in the 400 series. Two of the eight units must be earned in connection with a thesis, and the candidate is ordinarily expected to take Accountancy 481 and 483. The remaining four units of the eight required for the degree may be elected by the student upon the approval of his adviser. The candidate may elect one or more minors but must have at least four units in accountancy.

Degree of Master of Accounting Science (professional degree). This program is designed to give professional training in accountancy to candidates who wish to prepare for professional careers in public, governmental, or industrial accounting. Candidates for the Master of Accounting Science degree must present at least twenty-four semester hours of undergraduate work in accountancy, including a course in each of the areas of cost accounting, federal income tax accounting, auditing, and advanced problems. Eight units of graduate credit, including Accountancy 481, 483, and 594, are required. In addition, one or more minors of one to four units in a field or fields outside the area of accountancy are required. The minor field or fields to be selected and the number of units will be determined in consultation with the adviser and will depend upon the undergraduate background of the student, his educational objective, and other factors.

Each candidate must declare his intention of preparing for public accounting, governmental accounting, or industrial accounting. Those intending to enter public accounting ordinarily should take, in addition to the required courses previously mentioned, at least three of the following courses, including the first two named: Accountancy 472, 577, 471, 372, 374, and Business Administration 373.

Those preparing for careers as comptrollers, chief accountants, cost accountants, or executive positions in industrial or commercial enterprises ordinarily

should take at least three of the following courses, including the first two named: Accountancy 461, 466, 473, 362, 366, and Business Administration 373.

Those preparing for careers in local, state, or federal governments, or for accounting or administrative positions in nonprofit organizations, institutions, or government agencies ordinarily should take at least three of the following courses, including the first two named: Economics 414, Accountancy 441, 461, 466, 341, and Business Administration 373.

Program for Non-Commerce Graduates. A program is available which is designed to permit non-commerce graduates to earn a Master of Science degree in Accountancy or a Master of Accounting Science degree in approximately two years. Students with undergraduate degrees, but with no undergraduate work in accountancy, may remove entrance deficiencies during the first year by registering in the combined courses which are available, and which carry no graduate credit. These students then proceed with the regular graduate program during the second year of residence. Requests for further information should be addressed to the Head of the Department.

Degree of Doctor of Philosophy. A candidate for the Doctor of Philosophy degree must satisfy residence requirements, complete sixteen units of graduate course work (including eight units required for the master's degree), complete the foreign language requirements, pass the preliminary examination, satisfy the doctoral thesis requirements, and pass the final examination. In his preliminary examination the candidate must show a thorough knowledge of accounting theory; a thorough knowledge of certain areas of accountancy, the number and selection of which are to be determined by the adviser in consultation with the student; a general acquaintance with the subject matter and bibliography of other areas of accountancy; and proficiency in the field or fields outside the department offered as a minor or minors. The minor or minors must consist of at least four units and may not exceed eight units.

GRADUATE TEACHING FACULTY

Professors: C. A. Moyer (Head of Department), N. M. Bedford, R. I. Dickey, Dorothy Litherland, G. E. Lukas, R. K. Mautz, H. L. Newcomer, K. W. Perry, W. E. Thomas, N. D. Wakefield.

Associate Professors: G. D. Brighton, C. H. Griffin, R. E. Schlosser, D. H. Skadden, A. R. Wyatt, V. K. Zimmerman.

Assistant Professors: E. J. DeMaris, W. L. Ferrara, H. P. Holzer.

PROFESSIONAL COURSES

577. **Professional Problems.** Instruction as to types and methods of solution of professional problems in public accounting, including practice in analyzing and solving a wide variety of such problems. II; 1 unit. Griffin, Skadden.

594. **Methods and Practices in Professional Research.** Instruction in research methods, materials, and techniques together with individual practice in conducting and reporting on specific professional research projects. I; 1 unit. Zimmerman.

COURSES FOR GRADUATES

432. **Accounting under Different Social Systems.** An inquiry into the ways accounting has been adapted to the needs of different social systems; the extent of its contribution; its apparent limitations. Consideration is also given to the relationship between accounting and the growth and development of social systems. II; 1 unit. DeMaris.

441. **State and Federal Accounting Theory.** Advanced study in accounting and other fiscal procedures of the federal government; state, county, and municipal governments; institutions. II; 1 unit. LUKAS.

461. **Administrative Accounting.** Accounting as a tool for management: organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions, cooperation with public accountants and government agencies, and social responsibilities. II; 1 unit. THOMAS.

466. **Cost Accounting Theory and Analysis.** A critical examination of cost accounting methods as to truth and expediency. I; 1 unit. DICKEY.

471. **Accounting Reports.** Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. I; 1 unit. WAKEFIELD.

472. **Auditing Standards and Techniques.** A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. II; 1 unit. MAUTZ, MOYER.

473. **System Design and Installation.** Problems and procedures in connection with designing and installing accounting systems. I or II; 1 unit. SCHLOSSER.

474. **Income Tax Development.** A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. I; 1 unit. SKADDEN.

481. **Concepts and Principles.** The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. I, II; 1 unit. BEDFORD, GRIFFIN, MOYER, WYATT.

483. **Income Determination.** A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. II; 1 unit. BEDFORD, MAUTZ, PERRY.

484. **The Accounting Theory of Business Income.** An examination of the development and essential characteristics of the accounting theory of business income evaluated in the light of criticisms implicit in other concepts of income; the social significance of business income theory. I; 1 unit. MAUTZ.

487. **Surplus and Dividends.** The theories underlying the treatment of balance sheet items deserve close consideration in accounting, because the balance sheet reflects the effect of conflicting ideas about the bases for setting up restrictions on the freedom of directors to dispose of corporation assets as dividends. II; 1 unit. NEWCOMER.

489. **History of Accounting Theory.** An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. I; 1 unit. LITHERLAND, ZIMMERMAN.

493. **Special Research Problems.** Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. I, II; ¼ to 2 units. MOYER.

499. **Thesis Research.** Individual direction and guidance in writing theses, and seminar discussions of progress made. I, II; 0 to 4 units. BEDFORD, NEWCOMER, and others.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Advanced Accounting.** Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. I, II; ¾ unit. Prerequisite: Accountancy 106 and 108. Bedford, Griffin, Newcomer.

324. **Accounting Systems.** A discussion of the systems used by contractors, department stores, finance companies, building and loan associations, banks, insurance companies, brokers, water companies. I, II; ½ unit. Prerequisite: Accountancy 106 and 108. Schlosser.

341. **Governmental Accounting.** Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. I, II; ½ unit. Prerequisite: Accountancy 108. Brighton, Lukas.

362. **Business Budgets and Accounting Control.** Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. I; ¾ unit. Prerequisite: Accountancy 108. Thomas.

366. **Advanced Cost Accounting.** Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. I, II; ½ unit. Prerequisite: Nine hours of accountancy, including Accountancy 106. Dickey, Holzer, Thomas.

371. **Auditing.** Ethics of the accounting profession; auditing standards and procedures; programs of audit of various accounts; construction and indexing of working papers; report to clients. I, II; ¾ unit. Prerequisite: Accountancy 308. DeMaris, Mautz, Wyatt.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. I, II; ¾ unit. Prerequisite: Accountancy 371. Moyer, Wakefield, Wyatt.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. II; ¾ unit. Prerequisite: Accountancy 274 and 308. Brighton, Skadden.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. I, II; 1 unit. Prerequisite: Credit or registration in Accountancy 371. Griffin, Newcomer.

378. **C.P.A. Problems.** Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory, auditing, ethics. I, II; 1 unit. Prerequisite: Accountancy 377. Perry, Skadden.

Note: See also Business Administration 373, Electronic Data Processing for Business.

ADVERTISING

The Department of Advertising offers graduate work leading to the degree of Master of Science in Advertising. For the program leading to the Doctor of Philosophy degree in Communications, see page 105; for programs leading to Ph.D. majors and minors in related fields such as marketing and psychology, see other sections of this catalog.

Admission to graduate work in advertising requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in advertising or a related field, English, commerce, or the other social sciences, and (2) a grade-point average of at least 3.75.

Degree of Master of Science. Requirements for this degree include:

(1) A major of four units or three units and one additional unit approved by the adviser. Candidates must select at least two units from Advertising 481 and 482, and Journalism 471. Candidates without acceptable undergraduate majors must complete Advertising 382, 383, and 384.

(2) A minor of at least two units.

(3) A thesis of one or two units.

(4) A minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

GRADUATE TEACHING FACULTY

Professors: C. H. Sandage (Head of Department), L. W. McClure.
Associate Professor: J. E. Moyer.
Assistant Professor: H. W. Sargent.

COURSES FOR GRADUATES

481. **Advanced Advertising Principles.** Same as Communications 481 and Marketing 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Advertising 481 and 388. II; 1 unit. Sandage.

482. **Research Methods in Advertising and Communications.** Same as Communications 482 and Marketing 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. I; 1 unit. Sandage.

483. **Advertising and the Mass Media.** Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. I; 1 unit. Moyer.

490. **Special Topics in Advertising.** I, II; ½ to 1 unit. Prerequisite: Consent of head of department. Staff.

499. **Thesis Research.** I, II; 1 to 2 units. Prerequisite: Graduate standing in advertising. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

382. **Advertising Copy and Layout.** Same as Marketing 382. Theory and practice of advertising copy writing and layout for newspaper, magazine, and direct mail; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. I, II; 1 unit. Prerequisite: Journalism 204 or consent of instructor; Advertising 281. Sargent.

383. **Advertising Media.** Same as Marketing 383. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. I, II; ½ unit. Prerequisite: Advertising 281. Moyer.

384. **Advertising Campaigns.** Same as Marketing 384. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements — copy and layout. I, II; ½ unit. Prerequisite: Advertising 282 or 382, and 383. MOYER.

385. **Advertising Promotion and Sales.** Same as Marketing 385. Sales problems, advertising promotion, advertising research, market research. I, II; ½ unit. Prerequisite: Advertising 281. MCCLURE.

386. **Radio and Television Advertising.** Same as Marketing 386. Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. I, II; ½ unit. Prerequisite: Advertising 281. MCCLURE, SANDAGE.

387. **Advertising Policies and Problems.** Same as Marketing 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to management decision-making problems at the national level. I, II; ½ to 1 unit. Prerequisite: Advertising 281. WEDDING.

388. **Advertising in Contemporary Society.** Same as Marketing 388. A study of advertising as an institution and its role in communications, society, our economy, and business. Students may not receive graduate credit for both Advertising 388 and 481. I, II; ½ unit. Prerequisite: Advertising 281 or consent of instructor. SANDAGE.

AERONAUTICAL ENGINEERING

The Department of Aeronautical Engineering offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. The principal fields of study are aerodynamics, propulsion, structures and aeroelasticity, and astronautics. Programs of study and research are selected to prepare graduates for airplane, missile, and space flight engineering.

The minimum grade-point average for admission to graduate study in aeronautical engineering is 3.75.

The prerequisite for graduate study in aeronautical engineering is normally the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in aeronautical engineering. It is expected that graduate students with deficiencies in their aeronautical engineering background will demonstrate proficiency in the fundamentals of their chosen field by passing suitable courses or examinations to the satisfaction of their advisory committees.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Each student plans his study programs in consultation with a departmental advisor. Courses offered by departments other than aeronautical engineering may be included in the major area of study when these courses are of particular value to the work which students

desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical engineering must have taken mathematics through the first course in differential equations and undergraduate aeronautical engineering courses, equivalent to those offered at the University of Illinois, which are prerequisites to study in the branch of the subject in which the minor work is to be pursued. Where special cases warrant deviation from these requirements, approval from the head of the department is required.

For information concerning applied mathematics, see page 212.

GRADUATE TEACHING FACULTY

Professors: H. S. Stillwell (Head of Department), J. M. Coan, Jr., B. L. Hicks, H. H. Hilton, M. Z. Krzywoblocki, R. W. McCloy, A. I. Ormsbee.

COURSES FOR GRADUATES

410. **Non-Steady Aerodynamics.** Aerodynamic characteristics of aircraft components in non-steady motion, including the aerodynamics of flutter and buffeting, and internal non-steady flow phenomena. II; 1 unit. Prerequisite: Aeronautical Engineering 216; Mathematics 346 or 348; consent of instructor. Ormsbee.

411. **Advanced Aerodynamics of Compressible Fluids.** Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. I; 1 unit. Krzywoblocki.

412. **Theory of Turbulence.** Introduction to the classical and modern theories of turbulence: Reynold's, Prandtl's Kármán's, Kármán-Howarth's, Kolmogoroff's, Heisenberg's, Krzywoblocki's theories in compressible fluids; Kampe de Feriet's theory. II; 1 unit. Prerequisite: Consent of instructor. Krzywoblocki.

414. **Advanced Theory of the Boundary Layer, Wakes and Jets.** The modern concepts and solutions of the boundary layer theory (laminar and turbulent), including considerations of transition and stability as well as the applications to wake and jet theories. II; 1 unit. Prerequisite: Consent of instructor. Krzywoblocki.

415. **Wing Theory.** Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple body systems in subsonic and supersonic flow. I; 1 unit. Prerequisite: Mathematics 346 or equivalent. Ormsbee.

417. **Newtonian Flow and Elements of Missile Ballistics.** Fundamental concepts of Newtonian fluids; surface temperature of bodies in free molecular flow; equations of motion of a rocket during and after burning; properties of rocket functions; terrestrial and extra-terrestrial dynamics of rockets. II; 1 unit. Prerequisite: Aeronautical Engineering 306 and 411, or consent of instructor. Krzywoblocki.

421. **Advanced Aircraft Shell Structures.** Shear lag and diffusion of load in stiffened panels; relaxation methods; restrained warping of stiffened boxes with and without cutouts; exact and energy solutions for buckling of non-uniform columns, continuous columns, and plates. II; 1 unit. Prerequisite: Aeronautical Engineering 222 or consent of instructor. Coan.

426. **Theory of Continuous Media.** Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; nonlinear

strain relations; nonlinear equilibrium conditions; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. I; 1 unit. Prerequisite: Consent of instructor. HILTON.

427. **Thermal Stresses and Creep Buckling.** Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating of plastic and linear and nonlinear viscoelastic columns, plates, and shells; life expectancy of structures under elevated temperatures; minimum weight and probability of failure; applications to high speed airplane and missile structures. II; 1 unit. Prerequisite: Aeronautical Engineering 426 or consent of instructor. HILTON.

431. **Aerothermodynamics.** The fundamental principles of kinetic theory and of classical and statistical thermodynamics are reviewed as a basis for treating the gas imperfection, dissociation, chemical reactions, transport properties, and relaxation phenomena which occur in aerodynamic and combustion problems. I; 1 unit. Prerequisite: Aeronautical Engineering 216 and 233 and one physics course beyond general physics, or equivalent. HICKS.

451. **Aeroelasticity and Aeroinelasticity.** Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. II; 1 unit. Prerequisite: Aeronautical Engineering 250 or consent of instructor. HILTON.

490. **Seminar.** Presentation by graduate students and staff of current topics in the fields of aeronautics. I, II; 0 units. Prerequisite: Graduate standing in aeronautical engineering. ORMSBEE.

493. **Special Problems.** Theoretical and experimental investigations of problems in airplane, missile, and space flight engineering. I, II; 1 to 2 units. STAFF.

499. **Thesis Research.** Research in the various areas of the aeronautical sciences. I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Human Factors in Engineering for Space Travel.** Same as Physiology 304. Human factors decisive in the design and operation of manned space vehicles. I or II; ½ unit. Prerequisite: Graduate standing in biology, engineering, physical sciences, or psychology. JOHNSON, STILLWELL.

306. **Foundations of Mechanics and Gravitational Theory.** Same as Astronomy 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to earth, precession of earth's axis, etc. I or II; 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE.

311. **Aerodynamics of Perfect Fluids.** Fundamental equations; plane irrotational flow; vortex flow; combination fields of flow; Kutta-Joukowski theorem; application of conformal transformation to fields of flow; particle paths; fields of flow relative to axes fixed in fluid; velocity potential; three-dimensional fields. I; ½ unit. Prerequisite: Aeronautical Engineering 211. KRZYWOBLOCKI.

334. **Rocket Propulsion and Rocketry.** The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. II; ½ unit. Prerequisite: Mechanical Engineering 205 or equivalent, or consent of instructor. McCloy.

391. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. I, II; ½ to 1 unit. Prerequisite: Consent of Instructor. Staff.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the degrees of Master of Science and Doctor of Philosophy. The chief fields of specialization are farm management, land economics, marketing, prices and statistical analysis, and rural sociology. Graduate work is also offered in national agricultural policies and programs, finance, law as applied to agriculture, and in international comparative agriculture.

Students who desire to secure degrees in agricultural economics must have completed either (1) a course of study equivalent to that required for the degree of Bachelor of Science in Agriculture at the University of Illinois, and including twelve hours of agricultural economics and economics, or (2) twelve hours of undergraduate economics and agricultural economics, and at least eight hours in accountancy, business law, history, management, marketing, political science, or sociology. See also the requirements which must be met in order to take economics as a minor.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

The minimum grade-point average for admission to graduate study in agricultural economics is 3.5.

A candidate for the degree of Master of Science is required to register for at least two units in economics, including one unit of economic theory. For the degree of Doctor of Philosophy, he must complete a minimum of five units in the College of Commerce and Business Administration, including three units in economics, two of which must be in economic theory at the 400 level. One unit of research methodology and one unit of statistical methods, both at the 400 level, are required.

If approved by the Department of Agricultural Economics and the Dean of the Graduate College, the required work in economics may be treated as a part of the major field. Otherwise, the work in economics is considered a first minor, in which case the program in that minor requires the approval of the Department of Economics (see requirements in economics for a minor in that field).

To take agricultural economics as a minor, the student must have had at least twenty hours of undergraduate work in economics and agricultural subjects.

GRADUATE TEACHING FACULTY

Professors: H. G. Halcrow (Head of Department), C. B. Baker, R. W. Bartlett, W. D. Buddemeier (assigned to India 1959-1961), H. W. Hannah, T. A. Hieronymus, G. G. Judge, N. G. P. Krausz, D. E. Lindstrom, R. J. Mutti, E. R. Swanson, W. N. Thompson, V. I. West, J. E. Wills.

Associate Professors: E. E. Broadbent, C. L. Folse, R. A. Kelly, F. J. Reiss.

Agricultural Economics

COURSES FOR GRADUATES

401. **International Comparative Agriculture.** Agricultural and major food problems of various countries; procedures, national and international, for improved standards. I; 1 unit.

404. **Economics of Agricultural Production.** Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. II; 1 unit. Prerequisite: Economics 300 or an equivalent course in economic theory and one course in statistics. SWANSON.

405. **Economic Policies and Programs Affecting Agriculture.** Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. I; 1 unit. Prerequisite: One semester of graduate work or consent of instructor. HALCROW.

406. **Research Methodology in Agricultural Economics.** Methods of inquiry leading to information which is reliable and relevant to the solution of problems significant in the agricultural economy. II; 1 unit. Prerequisite: Economics 400 or 401 or a course of comparable level in the basic field related to the student's research. BAKER.

418. **Land Economics.** Land classification methods and principles; land tenure systems in modern societies; land deterioration and restoration as private and public problems. I; 1 unit.

425. **Farm Management Principles.** Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. Field trip; estimated expense, $8.00. I; 1 unit. WILLS.

436. **Problems in Marketing Agricultural Products.** Factors influencing growth of markets; methods of reducing costs and improving marketing processes; activities of government agencies; cooperative efforts. II; 1 unit. HIERONYMUS.

441. **Agricultural Statistics.** Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. I; 1 unit. Prerequisite. An elementary course in statistics. WEST.

442. **Agricultural Prices.** Prices of agricultural products in the light of their history, value theory, monetary theory, and methods of statistical analysis. II; 1 unit. Prerequisite: Agricultural Economics 441; a course in economic theory. JUDGE.

491. **Seminar and Special Topics.** Each graduate student whose major is agricultural economics must register in this course. These or other students who complete special studies under the direction of staff members receive credit. I, II; 0 to 2 units.

499. **Thesis Research.** Only those students who submit an acceptable thesis receive credit. I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Financing Agriculture.** Capital and credit needs of farmers; agencies supplying credit needs; problems of borrowers and lenders. II; ½ unit. Prerequisite: Economics 102 and 103, or 108. BAKER.

303. **Agricultural Law.** Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, taxation, and other problems involving agriculture. I, II; ½ unit. HANNAH, KRAUSZ.

305. **Agricultural Development and Policies.** Agricultural development in the United States presented as a basis for analyzing the effectiveness of past agricultural policies, delineating agricultural problems, and the need for developing sound agricultural policies in keeping with a sound national economy. I; ½ unit. THOMPSON.

312. **Farm Appraisals.** Same as Agronomy 312. Valuation of farm real estate; soils, crops, management, buildings, drainage, land titles, prices, and taxes in relation to value. Local field trips; estimated expense, $7.00. II; 1 unit. Prerequisite: Agronomy 201 and Agricultural Economics 220, or equivalent. REISS and others.

324. **Farm Operation.** Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5.00. II; ½ unit. Prerequisite: Agricultural Economics 220. WILLS.

325. **Advanced Farm Management.** Functions of management; planning for conservation and profit; fitting the livestock organization to the kind of crops produced and to market outlets; economic information for farm planning; measures of farm efficiency; labor and power problems. Field trips to study successful farms; estimated expense, $10.00. I; ½ to 1 unit. Prerequisite: Agricultural Economics 220.

326. **Professional Farm Management.** Principles of farm management applied to the problems of those managing farms for others as a profession; development of the profession; relationships with clients and farm operators; division of inputs and returns between owner and operator; direct operation of farms with hired labor; case problems; business practices and procedures; professional ethics. Field trips to farms and professional farm management offices, estimated expense, $10.00. II; ½ unit. THOMPSON.

331. **Grain Marketing.** Same as Marketing 331. Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially futures markets; inventory management, operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. I; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or consent of instructor. HIERONYMUS.

332. **Livestock Marketing.** Same as Animal Science 332 and Marketing 332. Problems and practices in marketing livestock. Field trip; estimated expense, $7.00. II; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or consent of instructor. BROADBENT.

334. **Marketing Dairy Products.** Same as Dairy Science 334 and Marketing 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5.00. II; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

335. **Economics of Food Distribution.** Same as Horticulture 335 and Marketing 335. Analysis of (a) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (b) effects of industry organization and government regulations on marketing functions and efficiency; (c) consumer demand for food. I; ½ unit. Prerequisite: Agricultural Economics 230 or equivalent; Economics 109. KELLY.

337. **Economic History of American Agriculture.** Same as Economics 337 and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. Graduate students who take this course for one unit credit are required to do extra work. The student writes a scholarly paper on some approved topic in agricultural history. I; ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history. JONES.

341. **Agricultural Statistics.** Statistical methods with special application to agricultural problems, including price behavior. Students receiving credit in this course will not receive credit in Agriculture 216. I; ½ unit. WEST.

342. **Agricultural Prices.** A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108.

Rural Sociology

COURSES FOR GRADUATES

407. **Population Studies and Demographic Analysis.** Same as Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections, relationship of economic, sociological, and psychological factors to population changes. I; 1 unit. FOLSE.

477. **Rural Communities.** Same as Sociology 477. A study of rural community structure, functions, and processes, to give the student a concrete picture of how rural communities operate, and the forces which cause change in the group life of the people living in a rural community. Field trip; estimated expense, $5.00. II; 1 unit. LINDSTROM.

487. **Special Problems in Rural Sociology.** Same as Sociology 487. I, II; ½ to 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

317. **Structure and Function of Rural Society in America.** Same as Sociology 317. A functional analysis of the group, institutional, and class structure of contemporary American rural society, with emphasis on regional and subregional variations and the interdependence of the rural and other segments of the total American society. I; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Three hours of sociology, eight hours of social science, or consent of instructor. FOLSE.

377. **Rural Community: Organization and Analysis.** The nature of the town-country community with special emphasis on its structure and organization, the institutional and agency programs and their leaders. Designed specifically for students preparing for vocational agriculture, extension, and other private and public agency work in rural areas. I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Three hours of sociology or eight hours of social science, or consent of instructor. FOLSE.

AGRICULTURAL EDUCATION

This is a program leading to the degree of Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching vocational agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of vocational agriculture, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Education 311 and 312 and two of the following courses: Education 301, 302, 303, 304. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department. A program of study suited to the student's objective is suggested by the adviser from courses listed under the departmental headings.

The minimum grade-point average for admission to graduate study in agricultural education is 3.5.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall, Professor H. M. Hamlin, 103 Gregory Hall, and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

The Department of Agricultural Engineering offers graduate work leading to the degree of Master of Science in Agricultural Engineering, with options for specialization in farm power and machinery, soil and water control, farm structures, rural housing, and rural electrification.

Candidates for the master's degree must have had the equivalent of the undergraduate curriculum at the University of Illinois. This specifically includes sound training in engineering fundamentals and at least twelve semester hours of advanced undergraduate engineering design courses.

The minimum grade-point average for admission to graduate study in agricultural engineering is 3.5.

GRADUATE TEACHING FACULTY

Professors: F. B. Lanham (Head of Department), H. H. Beaty, E. L. Hansen, R. C. Hay, K. H. Hinchcliff.

Associate Professors: B. A. Jones, Jr., D. F. Kampe, J. W. Matthews, G. C. Shove, J. A. Weber, R. R. Yoerger.

Assistant Professors: W. Bowers, J. O. Curtis, R. M. Peart.

COURSES FOR GRADUATES

436. Dynamics of Farm Machine Elements. Advanced study of the dynamics of farm machine elements with specific reference to functional operation,

stresses and fatigue life. I; 1 unit. Prerequisite: Agricultural Engineering 236 and 336, or equivalent. YOERGER.

446. **Farm Tractors.** A study of research findings that apply to farm tractors including tests of tractors and component parts, evaluation of transmission designs, travel efficiency, tractor stability and horsepower hour requirements for farm tractor operations. II; 1 unit. Prerequisite: Agricultural Engineering 346. WEBER.

471. **Farm Structures in Agricultural Production.** Farm structures as related to production, farm operation, and systems of farming; building management, functional requirements, cost and appraisal. Discussions, problem study, and reports. I; ½ unit. Prerequisite: Bachelor's degree in agriculture. HANSEN.

496. **Problems in Agricultural Engineering.** Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. I, II; 1 unit. Prerequisite: Bachelor's degree in agricultural engineering or other engineering curriculum, with credit in courses essential to the optional line of study; consent of head of department. STAFF.

499. **Thesis Research.** I, II; 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** An agricultural problem with engineering implications is selected for study, investigation, and report wherein a satisfactory solution does not require a background of engineering education. For non-engineering students only. I, II; ½ unit. Not open to students on probation. Prerequisite: Minimum grade-point average of 3.5; senior standing; consent of instructor and head of department. Specific approval of the Associate Dean in advance of registration is required for a second special problem course. STAFF.

331. **Function, Application, Adjustment, and Management of Farm Machinery.** A study of field and farmstead machinery as related to the needs of agricultural production, systems of farming, function, construction, maintenance, and operation costs. S; ½ unit. Offered in 1961 and in alternate years. Prerequisite: Agricultural Engineering 112 or 131, or consent of instructor. BOWERS.

336. **Design of Agricultural Machinery.** Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of design to problems. II; ½ unit. Prerequisite: Mechanical Engineering 271. KAMPE.

346. **Farm Power.** Basic theory, analysis, and testing of internal combustion engines specifically for use in farm tractors, and other farm power application. I; ½ unit. Prerequisite: Mechanical Engineering 209. WEBER.

355. **Advanced Soil and Water Conservation Practices.** A study of conservation practices and their evaluation in relation to farm operations; planning, constructing, and checking of terraces, waterways, diversion ditches, and drainage systems. II; ½ unit. Prerequisite: Agricultural Engineering 111 or 252, or consent of instructor. JONES.

356. **Soil Conservation Structures.** Hydrology, hydraulics, design, construction, and cost estimating of soil and water conservation structures; relationship of slopes, soils, crops, and practices in soil conservation and flood control. II; ½ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234; Agricultural Engineering 277. JONES.

357. **Land Drainage.** The design, construction, performance, and maintenance of

surface tile and open ditch drainage systsems. I; ½ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. JONES.

361. **Development and Function of Family Housing.** Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure, economic influences, costs, and adaptations; personal and public interests. II; ½ unit. HINCHCLIFF.

376. **Advanced Design of Farm Structures.** Timber, steel, and concrete building design, with emphasis on structures for agricultural production. II; ½ unit. Prerequisite: Civil Engineering 262; Agricultural Engineering 277. HANSEN.

381. **Farm Electrical Equipment.** Advanced course. Exploration and evaluation of the factors involved in the selection, arrangement, installation, and operation of equipment for applying electricity to farming operations. II; ½ unit. Prerequisite: Agricultural Engineering 281 or graduate standing in agriculture, or consent of instructor. BEATY.

387. **Agricultural Process Engineering.** Principles, design factors, equipment, and controls of systems for drying, refrigerating, reducing, pelleting, blending, cleaning, sorting, and treating agricultural crops and products. II; ½ unit. Prerequisite: Agricultural Engineering 286 or Chemical Engineering 363. BEATY.

396. **Special Problems.** An agricultural problem is selected for study, investigation, and report wherein a satisfactory solution requires a strong background of engineering education. I, II; ½ unit. Prerequisite: Senior standing in engineering. STAFF.

AGRONOMY

The Department of Agronomy offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, crop production, ecology, experimental design, forage crops, morphological development, physiology, plant chemistry, weeds and their control; or (2) soils: biology, chemistry and biochemistry, fertility, genesis and classification, management, physical and colloidal chemistry, physical edaphology, physics.

The student must show promise of achievement in his chosen field, must have a grade-point average of 3.5 or higher for the last 50 per cent of his undergraduate work, and must be approved by the Department of Agronomy. For students having a grade-point average below 3.75, only those having unusually strong training in the basic sciences are considered for admission.

Fifteen semester hours in agronomy and related subjects are prerequisite for a minor and five additional hours for a major, but students with an unusually broad and thorough training in science may be exempted from certain of these requirements.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, bacteriology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics. A pamphlet giving specific prerequisites and requirements may be obtained from the head of the Department of Agronomy.

A candidate for the Master of Science degree must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units fulfill the requirements for a first minor for the Doctor of Philosophy degree.

More detailed information may be obtained by writing to the Department of Agronomy.

GRADUATE TEACHING FACULTY

Professors: M. B. Russell (Head of Department), S. R. Aldrich, O. T. Bonnett, R. H. Bray, E. B. Earley, J. E. Gieseking, J. A. Jackobs, W. C. Jacob, R. W. Jugenheimer, L. T. Kurtz, A. L. Lang, E. R. Leng, S. W. Melsted, R. T. Odell, E. H. Tyner.

Associate Professors: D. E. Alexander, A. H. Beavers, C. M. Brown, A. W. Burger, H. H. Hadley, R. H. Hageman, J. B. Hanson, C. N. Hittle, A. Klute, J. W. Pendleton, D. B. Peters, F. W. Slife, F. J. Stevenson.

Assistant Professors: R. W. Howell, E. B. Patterson, R. D. Seif, R. O. Weibel, J. T. Woolley.

COURSES FOR GRADUATES

401. **Soils Seminar.** I, II; ¼ unit. Staff.

402. **Chemical Properties of Soils: Their Relation to Soil Development and Plant Growth.** Chemical properties of soils and soil materials; their significance in soil development and in growth and nutrition of crop plants. Lectures, discussions, assigned reading, and bibliography. I; 1 unit. Prerequisite: Agronomy 201 and Chemistry 101, 105, and 122, or equivalent. Melsted.

403. **Genesis, Morphology, and Classification of Soils.** Historical review of work in soil genesis; genetic factors of soil formation; soil-forming processes and reactions; classification and nomenclature of soils; properties and distribution of the major soil groups of the world. Assigned reading. I; ¾ unit. Prerequisite: Agronomy 301 or consent of instructor.

405. **Colloidal Chemistry of Soils.** Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. II; 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Gieseking.

411. **Soil Physics.** The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned reading. I; 1 unit. Prerequisite: Chemistry 340 or equivalent. Klute.

412. **Soil Organic Matter.** Basic considerations in organic matter transformation; the carbon and nitrogen cycles; microbiology of organic matter synthesis; chemical nature of soil organic matter. Lectures, discussions, and assigned reading. II; 1 unit. Prerequisite: Bacteriology 104; Chemistry 132. Stevenson.

421. **Crops and Plant Breeding Seminar.** I, II; ¼ unit. Staff.

422. **Pasture, Range, and Soil Conservation Research.** Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. II; 1 unit. Prerequisite: Agronomy 121 and 321 or 322. Jackobs.

423. **Theory and Analysis of Plant Breeding Problems.** Genetics of crop plants; problems in selection and hybridization. II; 1 unit. Leng.

424. **Mineral Nutrition of Plants.** Same as Botany 424 and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. II; 1 unit. Prerequisite: Botany 130 or consent of instructor. Hageman.

25. **Development of Crop Plants in Relation to Production and Breeding.** Theories of morphology and morphogenesis; principles of development and differentiation; morphogenesis of crop plants; plant development in relation to crop production and breeding. Special emphasis on cereals and grasses. Lectures, demonstrations, and assigned reading. II; 1 unit. Prerequisite: Agronomy 121; Botany 100. Bonnett.

440. **Design and Analysis of Biological Experiments, I.** Same as Animal Science 440, Dairy Science 440, Horticulture 440, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. Jacob.

441. **Design and Analysis of Biological Experiments, II.** Same as Animal Science 441, Dairy Science 441, Horticulture 441, and Veterinary Medical Science 441. A continuation of Agronomy 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Agronomy 440 or equivalent. Jacob.

499. **Thesis Research.** I, II; 0 to 4 units.
(a) **Soils.** Aldrich, Beavers, Bray, Gieseking, Klute, Kurtz, Lang, Melsted, Odell, Peters, Russell, Stevenson, Tyner.
(b) **Crops.** Alexander, Bonnett, Brown, Burger, Earley, Hadley, Hageman, Hanson, Hittle, Howell, Jackobs, Jacob, Jugenheimer, Leng, Patterson, Pendleton, Seif, Slife, Weibel, Woolley.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Special Problems.** Individual problems in crops or soils. Graduate students majoring in agronomy do not receive graduate credit. I, II; ½ to 2 units. Prerequisite: Consent of instructor.

301. **Soil Survey, with Emphasis on Illinois Soils.** Properties and methods used in distinguishing soils; characteristics and distribution of different soils in Illinois and the cause of these soil differences; the influence of differences in Illinois soils upon their proper use and management. Laboratory work includes instruction in the use of soil maps, training in mapping soils, and field trips to examine representative Illinois soils. Field trips; estimated expense, $15.00. II; ½ unit. Prerequisite: Agronomy 201. Odell.

302. **Role of Microorganisms in Soil Fertility.** Microorganisms of the soil in relation to fertility; nitrogen fixation, assimilation, and preservation. I; ½ unit. Prerequisite: Agronomy 201.

305. **Soil Physics.** Introductory and advanced laboratory experiments illustrating principles and methods of physical studies of soils. The work is graded according to the previous training of the student. I; 1 unit. Prerequisite: Agronomy 201 or equivalent; consent of instructor. Klute.

306. **Fertilizers and Their Soil Reactions.** Fertilizer sources and materials; chemical forms of elements in the soil, reactions of fertilizers in soils, determination of fertilizer needs, soil test methods, fertilizer application. I; ½ unit. Prerequisite: Agronomy 201. Bray.

307. **Principles of Soil Conservation.** National and local implications of soil conservation and its relation to farming systems, land management, climate, soil character and farming operations. II; ½ unit. Prerequisite: Agronomy 121 and 201.

308. **Plant Composition and Chemurgy.** Supply, chemical composition, and utili-

zation of the principal sugar, starch, cellulose, oil, and protein crops of the world; the effect of nutritional, environmental, and genetic factors on chemical composition of these crop plants. II; ½ unit. Prerequisite: Chemistry 132 or equivalent. EARLEY.

311. **Physical Edaphology.** The underlying principles of the influence of physical properties of soils on plant growth; the application of these principles to practical problems of tillage, drainage, conservation, and plant nutrition. II; ½ unit. Prerequisite: Agronomy 201. RUSSELL.

312. **Farm Appraisals.** Same as Agricultural Economics 312. Valuation of farm real estate; soils, crops, management, buildings, drainage, land titles, prices, and taxes in relation to value. Local field trips; estimated expense, $7.00. II; 1 unit. Prerequisite: Agronomy 201 and Agricultural Economics 220, or equivalent. REISS and others.

321. **Ecological and Physiological Factors Affecting Crop Production.** The environmental requirements of crop plants and their physiological bases; the adequacy of the environment provided by crop land in the United States as a function of management, soils, and climate; the distribution and yield of selected crops as a function of environment. I; ½ unit. Prerequisite: Botany 100; Chemistry 132 or 133. HANSON.

322. **Forage Crops and Pastures.** Roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. Lectures and discussions. II; ½ unit. Prerequisite: Agronomy 121. JACKOBS.

323. **Improvement of Farm Crops by Breeding.** Heredity and variation in crop plants; effects of self-fertilization and cross-fertilization; principles and results of selection and hybridization in crop improvement. I; ½ unit. Prerequisite: Agronomy 110 or equivalent; Agronomy 121. HADLEY.

325. **Corn Breeding, Genetics, and Seed Production.** Principles and procedures involved in developing and evaluating inbred lines and hybrids; genetics of corn; production and processing of hybrid seed corn. II; ¾ unit. Prerequisite: Agronomy 110 or consent of instructor. LENG.

326. **Weeds and Their Control.** Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. Field trip; estimated expense, $5.00. I; ½ unit. Prerequisite: Agronomy 121. SLIFE.

327. **Forage Crop Breeding.** Principles and methods of plant breeding as related to forage crops; sources of hereditary variation, identification of desirable types, methods of evaluating breeding materials, and the utilization of desirable variations; cytological, genetical, and breeding investigations of the more important forage species and the development of improved varieties. I; ½ unit. Prerequisite: Agronomy 110 or equivalent; Agronomy 323 or consent of instructor. Offered in 1960-1961 and in alternate years. HITTLE.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Mathematics 365. A study of methods for efficient utilization of high speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Students are expected to solve problems on the computers. I; 1 unit. Prerequisite: Mathematics 295 and a course in statistics or statistical methods, or equivalents, or consent of instructor. JACOB.

377. **Diseases of Field Crops.** Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Plant Pathology 301 or consent of instructor. HOOKER.

ANIMAL SCIENCE

(Including Animal Nutrition)

The Department of Animal Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Animal Science. Research may be pursued in the following areas of specialization: (1) population and immuno genetics, (2) physiology of reproduction including endocrinology, (3) animal nutrition, (4) nutritional biochemistry, and (5) meats technology. In addition, a student who expects to terminate the graduate program at the master's level may pursue work in animal production. Beef cattle, poultry, sheep, swine, and a wide variety of laboratory animals are available for use in conducting research in the above areas.

The minimum grade-point average for admission to graduate study in animal science is 3.5.

Courses in biological and physical sciences and mathematics are essential preparation for graduate work in any specialized area of animal science. Candidates specializing in the areas of animal nutrition or nutritional biochemistry must have training equivalent to one five-hour course each in quantitative analysis and organic chemistry, and a course in physical chemistry is strongly recommended. Candidates specializing in meats technology should have had undergraduate training in meat evaluation, use, and/or processing, and in microbiology. Students lacking adequate background to register in graduate courses at the University of Illinois are expected to remove course deficiencies during the first year of graduate study.

GRADUATE TEACHING FACULTY

Professors: O. B. Ross (Head of Department), D. E. Becker, L. E. Card, R. M. Forbes, U. S. Garrigus, T. S. Hamilton, B. C. Johnson, W. G. Kammlade, J. Kastelic, A. V. Nalbandov, A. L. Neumann, H. W. Norton, H. M. Scott, S. W. Terrill, R. J. Webb.

Associate Professors: R. F. Nystrom, G. Wolf.

Assistant Professors: B. C. Breidenstein, H. H. Draper, P. J. Dziuk, E. E. Hatfield, A. H. Jensen, J. M. Lewis, S. P. Mistry.

Animal Science

COURSES FOR GRADUATES

400. **Seminar.** A review of current literature in the science of animal production. I, II; ¼ unit. Prerequisite: Consent of instructor. Staff.

401. **Principles of Beef Production.** A critical study of the objectives, design, and results of beef cattle experiments. I; 1 unit. Prerequisite: Consent of instructor. Neumann.

402. **Principles of Sheep and Wool Production.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. II; ½ unit. Prerequisite: Consent of instructor. Garrigus.

403. **Principles of Swine Production.** A critical study and interpretation of experiments in swine feeding, breeding, and management. Intended to aid in preparing students for positions in colleges, experiment stations, and related fields. II; ½ unit. Prerequisite: Consent of instructor. Terrill.

404. **Principles of Poultry Production.** A discussion of research methods and findings in the field of poultry science, with some consideration of current industry problems. I; ½ unit. Prerequisite: Consent of instructor. Scott.

405. **Advanced Animal Genetics.** Genetic theory, analysis of animal breeding problems, genetic results of selection and different systems of breeding. I; 1 unit. Prerequisite: Animal Science 305 or equivalent. LASLEY.

406. **Physiology of Reproduction.** Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. II; 1 unit. NALBANDOV.

407. **Laboratory Methods in Animal Genetics.** I, II; ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. LASLEY.

408. **Laboratory Methods in Physiology of Reproduction.** I, II; ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NALBANDOV.

410. **Research Methods in Animal Science.** Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. I, II; ¼ to 1 unit. Prerequisite: Consent of instructor. BREIDENSTEIN, GARRIGUS, NEUMANN, SCOTT, TERRILL, and others.

411. **Population Genetics and Animal Breeding.** Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. II; 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy 440, Dairy Science 440, Horticulture 440, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. JACOB.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy 441, Dairy Science 441, Horticulture 441, and Veterinary Medical Science 441. A continuation of Animal Science 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Animal Science 440 or equivalent. JACOB.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Beef Production.** The principles of feeding and management of beef cattle; financial aspects of beef production. Lectures, demonstrations, and discussions. I, II; ¾ unit. Prerequisite: Animal Science 102. NEUMANN.

302. **Sheep Production.** The sheep and wool industries; principles and practices of various phases of production. II; ¾ unit. Prerequisite: Animal Science 102. GARRIGUS.

303. **Pork Production.** The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. I, II; ¾ unit. Prerequisite: Animal Science 102. BECKER, JENSEN, TERRILL.

304. **Poultry Management.** Poultry science and practice with special reference to the place of the poultry enterprise on Illinois farms. Veterinary students are required to take the laboratory. All others may register with or without the laboratory. II; ¾ unit. Prerequisite: Animal Science 102. SCOTT, BRAY.

305. **Genetics and Animal Improvement.** Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement.

II; ¾ unit. Prerequisite: Animal Science 110 or equivalent. LASLEY, TOUCHBERRY.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. I; ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. VANDEMARK.

332. **Livestock Marketing.** Same as Agricultural Economics 332 and Marketing 332. Problems and practices in marketing livestock. Field trip; estimated expense, $7.00. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. BROADBENT.

Animal Nutrition

COURSES FOR GRADUATES

402. **Proteins and Amino Acids in Nutrition.** Methods of nutritional evaluation of proteins; nutritional requirements for individual amino acids; metabolism of the amino acids and of proteins in various species. I; ½ unit. Prerequisite: Chemistry 350 and 355. JOHNSON.

403. **Laboratory Methods in Protein and Energy Nutrition.** Techniques in protein evaluation and energy metabolism studies in nutrition investigations. I; 1 unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. FORBES.

404. **Carbohydrates, Lipids, and Energy in Animal Nutrition.** Basic principles of energy metabolism and their application to animal nutrition; caloric and non-caloric roles of carbohydrates and lipids in nutrition; influence of the rumen on energy utilization. II; ½ unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. FORBES.

405. **Animal Nutrition Seminar.** Discussions of original literature pertinent to animal nutrition. I, II; ¼ unit. Prerequisite: Consent of instructor. STAFF.

406. **Mineral Elements in Nutrition.** Nutritional requirements for individual mineral elements; physiological function; metabolism in animals; conditions contributing to mineral deficiency diseases in animals. I; ½ unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. KASTELIC.

407. **Vitamins in Nutrition.** Naturally occurring and synthetic forms of the vitamins and their biological activity for laboratory and domestic animals; clinical tests for vitamin deficiencies; metabolic products formed by different animals; functional forms of the vitamins and reactions in which they are involved; antimetabolites used in experimental nutrition. II; ½ unit. Prerequisite: Chemistry 350 and 355. DRAPER.

408. **Laboratory in Biochemical Problems in Vitamin and Mineral Nutrition.** Experiments in the production of vitamin and mineral deficiencies in the intact animal followed by tissue and cellular studies for characteristics of biochemical lesions. Labeled compounds are used when necessary to demonstrate the biochemical effects of a particular deficiency. II; 1 unit. Prerequisite: Chemistry 350 and 355. MISTRY.

496. **The Use of Carbon-14 in Labelling Techniques.** Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. II; 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. NYSTROM, WOLF.

499. **Thesis Research.** I, II; 0 to 4 units. DRAPER, FORBES, JOHNSON, KASTELIC, MISTRY, WOLF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Animal Nutrition.** An introduction to the principles and practical applications of the science of animal nutrition. Required for an undergraduate major in animal science. I; ¾ unit. Prerequisite: Animal Science 102; Chemistry 132 or 133. DRAPER.

351. **Principles of Animal Nutrition.** Studies of nutrient requirements of animals; function and utilization of nutrients; evaluation of nutritional adequacy and status; nutritional deficiency diseases; feeding and dietary standards. II; ¾ unit. Prerequisite: Chemistry 350 and 355, or Chemistry 354. KASTELIC.

ANTHROPOLOGY

The Department of Anthropology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy in Anthropology. Course work is available in the main branches of cultural anthropology and in physical anthropology, with opportunities for specialized training in ethnology, linguistics, social anthropology, and archaeology.

Applicants for admission to first-year graduate study in anthropology must meet the following requirements in order to be admitted with full standing: (1) fulfillment of the general requirements of the Graduate College, and (2) a grade-point average of at least 3.5. A graduate student who is admitted without a general background of preparation in anthropology, such as would be provided by an undergraduate major or its equivalent, may be permitted to register for graduate courses, but he is required to make up his deficiencies to the extent and in the manner prescribed by his adviser by taking specified undergraduate courses without graduate credit.

Degree of Master of Arts. Requirements for this degree are: the satisfactory completion of an approved program of eight units of work, including an acceptable thesis which embodies the results of an original research project the plan for which must have been approved in advance by the student's committee; and the passing of a written qualifying examination covering the major fields of anthropology (archaeology, ethnology, linguistics, physical anthropology, and social anthropology).

The student's program of work for the degree of Master of Arts is supervised by a committee consisting of the adviser and one additional member of the anthropology graduate faculty.

Degree of Doctor of Philosophy. The applicant who has obtained his Master of Arts degree from the University of Illinois is judged as to his qualifications for further advanced work on the basis of his record and his performance on the qualifying examination taken for the master's degree. The applicant whose previous graduate work was done elsewhere may be admitted on a provisional basis and may be required to take a general examination covering the major fields of anthropology. The results of this examination serve to determine the student's eligibility to continue in the doctoral program and to ascertain the amount of credit toward the doctoral requirements to be allowed for work completed elsewhere.

Candidates for the Ph.D. must complete one course of linguistics and one course of physical anthropology and must have a thorough knowledge of the ethnology and archaeology of North American Indians and of one other major culture area.

The prerequisite for a graduate minor in anthropology is six semester hours of undergraduate credit in anthropology. Before registering for courses, a student intending to offer anthropology as a minor subject should consult with the chair-

man of the department who will refer him to an anthropologist for advice and direction.

Upon the recommendation of his adviser, and after he has complied with the relevant regulations of the Graduate College, the student may apply in writing to the Anthropology Committee for admission to the preliminary examination. This examination tests the candidate's knowledge of his minor fields, and his proficiency in the history, theory, methods of research, and substantive content of his field of specialization in anthropology and in the application of statistical techniques to anthropology. He is also examined on his basic knowledge and understanding of the major subdivisions of anthropology that lie outside his field of specialization. An essential requirement of every candidate for the Ph.D. in anthropology is the capacity for original and creative research as demonstrated by the preparation of the doctoral dissertation. Dissertations are preferably based on field research. The student should consult with his adviser on this matter from time to time for guidance in his training in research methods and in the planning of his dissertation project.

GRADUATE TEACHING FACULTY

Professors: J. B. Casagrande (Head of Department), O. Lewis, J. C. McGregor, J. H. Steward.
Associate Professor: R. F. Gray.
Instructors: Elaine A. Bluhm, R. E. Downs, D. W. Lathrap, F. K. Lehman.

COURSES FOR GRADUATES

450. **Seminar in Anthropology.** Analysis of selected topics of special interest in anthropology. I or II; 1 unit. Students may reregister in this course up to a total of two units.

451. **Primitive Social Structure.** This course is intended to acquaint the student with the descriptive techniques and methods of analysis currently employed by social anthropologists in the study of primitive social groups and their modes of operation. I or II; 1 unit.

452. **Research Problems in Archaeology.** Seminar oriented to current research problems in archaeology, designed to acquaint students with theoretical and methodological aspects of particular problems, and to develop a critical perspective of archaeological research. Course may be repeated for additional credit. I or II; 1 unit. Prerequisite: Consent of instructor. McGregor.

460. **Theories and Methods in Anthropology.** A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. I or II; 1 unit. Casagrande.

461. **The Cultural Approach in Anthropology.** Seminar on the historical, comparative, and holistic methods of anthropology. I or II; 1 unit. Prerequisite: Consent of instructor. Steward.

462. **Cultural Method and Contemporary Native Populations.** Seminar on the use of anthropological methods in the analysis of native populations, with special reference to studies of communities, classes, castes, and other subcultural groups. I or II; 1 unit. Prerequisite: Anthropology 461 or consent of instructor. Steward.

463. **Seminar on Field Methods and Research Designs in Cultural Anthropology.** Critical examination of field methods and research designs as reflected in selected studies covering the past seventy years, ranging from early missionary reports to those of contemporary field workers. An effort is made to discern major trends in methodology. Community studies and compara-

tive studies on both the tribal and peasant levels are examined. I or II; 1 unit. Prerequisite: Consent of instructor. LEWIS.

489. **Readings in Anthropology.** Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interests of the student. I, II; ½ to 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser. STAFF.

490. **Individual Topics in Anthropology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. I, II; ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** Preparation of theses. I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **The Evolution and Races of Man.** Man's place in nature; the principles of biological evolution and genetics as exemplified by fossil evidence for man's evolution and the existing races of men. I or II; 1 unit. Prerequisite: Anthropology 102 or consent of instructor. LATHRAP.

350. **The Archaeology of South America.** The peopling of the continent and the subsequent rise of agricultural economies. Emphasis is placed on the spectacular rise of civilization in the region of the Central Andes. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 or consent of instructor. LATHRAP.

351. **Archaeological Surveying and Primitive Settlement Patterns.** Problems and methods of archaeological surveying; consideration of archaeological data and its relation to geographical and ecological factors for particular areas; problems of analysis and interpretation of data in terms of aboriginal settlement patterns using comparative data from ethnology and archaeology. Course includes laboratory work. I or II; ½ unit. Prerequisite: Consent of instructor.

352. **The Precolumbian Civilizations of Mesoamerica.** The major civilizations of Mexico and Guatemala are studied. Emphasis is placed on the growth and ramification of the several major cultural traditions and on the kinds of evidence which are available as a basis for the study of the growth of political units and their interaction. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 or consent of instructor. LATHRAP.

353. **Southwestern Archaeology.** Detailed study of one archaeological unit in the United States. Covers the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. MCGREGOR.

354. **Field Techniques in Archaeology.** An intensive six-week course in the field techniques and methods employed in American archaeology, covering all phases of such training from setting up a field camp, through excavation, recording, cataloging, and preliminary field study to partial evaluation. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. MCGREGOR.

355. **Laboratory Techniques and Problems in Archaeology.** Training in the laboratory methods and techniques of dealing with archaeological problems. A specific problem is assigned to each student for solution. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. MCGREGOR.

356. **Physical Anthropology.** The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. I or II; 1 unit. Prerequisite: Anthropology 102 and 103, or, with consent of instructor, a course in anatomy or comparative anatomy, or physiology, or introductory zoology. McGregor.

357. **Midwestern Prehistory.** A detailed study of midwestern archaeological area covering the broad cultures with regional variations considered chronologically and stressing their interrelationships. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. McGregor.

360. **Peoples of Oceania.** A survey of the groups inhabiting the islands of the Pacific, including Australia. I or II; ½ or 1 unit. Prerequisite: Three hours of sociology or anthropology, or consent of instructor.

361. **Ethnology of Middle America.** A survey of the people and cultures of Middle America with special emphasis upon Mexico and Guatemala. Begins by placing Middle America geographically, historically, and culturally within the broader Latin-American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Lewis.

362. **Patterns of Folk and Peasant Cultures.** An analysis of the development of folk and peasant cultures in various parts of the world. Data are drawn from archaeological and historical records as well as from contemporary ethnological studies. I or II; ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

363. **Religion in Primitive Society.** An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. I or II; ½ or 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Anthropology 102 and 103, or consent of instructor. Lewis.

364. **Field Work in Cultural Anthropology.** Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. Lewis.

365. **Analysis of Field Data in Cultural Anthropology.** Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; consent of instructor. Lewis.

366. **Peoples of Southeast Asia and Indonesia.** Survey of native cultures, economic bases, social and political structure, religion, arts, culture history, and racial types. The course deals in general with several of the following areas: the Indo-Chinese peninsula, Malaya, the Philippines, and the Malay Archipelago. Intensive study of one or two selected ethnic or tribal groups. I or II; ½ or 1 unit. Prerequisite: One course in anthropology or consent of instructor.

367. **Cultures of Native Africa.** A survey of the native cultures of Africa with particular emphasis on the development of culture types and the patterns of behavior associated with them. I or II; 1 unit. Prerequisite: Sociology 104 or consent of instructor. Gray.

368. **Peoples and Cultures of India.** A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. I or II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: One course in anthropology or sociology, or consent of instructor. LEWIS.

370. **Language, Culture, and Society.** Same as Humanities 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. I or II; ½ or 1 unit. MACLAY.

371. **Culture and Personality.** A cross-cultural comparative analysis and evaluation of current theories of culture and personality formation as developed by anthropologists and, in part, with the collaboration of psychologists. A critical examination is also made of recent studies of national character. I or II; ½ or 1 unit. Prerequisite: An introductory course in anthropology, sociology, or psychology, or consent of instructor.

372. **The Anthropological Study of Art.** A review of the anthropological approach to art with emphasis on structural analysis and the relationship of the artist to his culture. Problems of stylistic development are considered within the framework of cultural dynamics, and a survey of the major art style areas outside of the Western tradition and the Orient is included. I or II; ½ or 1 unit. Prerequisite: Three hours of anthropology or consent of instructor. LATHRAP.

380. **Applied Anthropology.** The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in non-industrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. I or II; ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

381. **Russian Culture History and Ethnology.** A historical and structural analysis of the development of Russian culture, especially the peasant traditions, from Danubian to contemporary times. I or II; ½ or 1 unit.

382. **Siberian Culture History and Ethnology.** An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. I or II; ½ or 1 unit.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the degrees of Master of Architecture and Master of Science in Architectural Engineering. Fields of specialization are architectural design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles); advanced structural theory and design; materials and methods of construction; history of architecture.

The prerequisite for graduate study in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. The minimum grade-point average for admission to graduate study in architecture

is 3.5. All applications for admission should be accompanied by samples of the applicant's work in structures and design.

Students are expected to follow one of the recommended area programs unless approval is obtained from the chairman of the department for a special program. A minimum of eight units must be completed for the master's degree.

GRADUATE TEACHING FACULTY

Professors: A. K. Laing (Chairman of Department), W. L. Creese, G. Guevrekian, G. S. Keith, D. B. Lindsay, R. P. Link, E. I. Love, R. J. Smith, E. F. Toth, A. R. Williams.

Associate Professors: G. T. Clayton, E. A. Connally, P. H. Coy, E. M. Farnham, G. M. Hodge, Jr., H. L. Hornbeak, C. B. Looker, J. G. Replinger.

COURSES FOR GRADUATES

417. **The Development of Contemporary Architectural Thought.** An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, van der Rohe, Viollet-le-Duc, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, Serlio, and Vitruvius. I, II; ½ unit. Prerequisite: Consent of instructor. Laing.

431. **Advanced Theory of Architecture.** A review of principles of architecture; factors in programming architectural requirements; schematics and design development; analysis and criticism. I; ½ unit. Prerequisite: Consent of instructor. Williams.

432. **Seminar in Architectural Design.** The analysis and criticism of selected buildings. Individual reports and discussion. II; ½ unit. Prerequisite: Architecture 431 or consent of instructor. Williams.

435. **Advanced Architectural Design.** Advanced study of space relationships, building groups, and the integration of structural, mechanical, and aesthetic elements in architecture. I, II; 2 units. Prerequisite: The degree in architecture (general option) offered by the University of Illinois, or equivalent. Williams.

452. **Advanced Theory of Structures.** Slope-deflection and moment-distribution methods applied to gable frames and members with variable cross-section; the column-analogy method; fixed arches; secondary stresses; composite structures; complex structures. I or II; 1 unit. Prerequisite: Civil Engineering 461 or consent of instructor.

454. **Advanced Structural Design in Reinforced Concrete.** Critical review of the methods and specifications involved in the design for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way and flat-slab floor construction; columns and footings; rigid frames and fixed arches; torsion; plastic theory of design; continuity in building design; introduction to prestressed concrete. I or II; 1 unit. Prerequisite: Architecture 358 or consent of instructor.

456. **Matrix Methods of Structural Analysis.** Use of matrices in the analysis of statically indeterminate structures; matrix operations on the electronic computer; analysis of trusses and rigid frames by redundant-force and displacement methods; applications to multi-span gable frames and tall building frames and to earthquake analysis of tall buildings. II; 1 unit. Prerequisite: Architecture 452.

481. **Advanced Architectural Construction.** A study of traditional and contem-

porary building construction techniques; cost, maintenance, and depreciation factors in the building industry. May be taken concurrently with Architecture 491. I, II; ½ unit. Prerequisite: Consent of instructor. CLAYTON.

491. **Special Problems in Architectural Construction.** Individual direction in the investigation of selected topics in building construction. I, II; ½ to 2 units. Prerequisite: Credit or registration in Architecture 481. CLAYTON.

493. **Special Problems in Structural Theory and Design.** I, II; ½ to 2 units. Prerequisite: Credit or registration in Architecture 452.

494. **Special Problems in Architectural Design.** Individual or group investigation of building types, aesthetic problems, and other aspects of architecture. I, II; ½ to 2 units. Prerequisite: Architecture 435. WILLIAMS.

496. **Special Problems in History of Architecture.** Individual investigation of the work of particular architects, specific buildings, or the architecture of periods or regions; comparative studies; aesthetic problems. I, II; ½ to 2 units. Prerequisite: Architecture 417 or consent of instructor. CONNALLY, CREESE, LAING.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Architectural Design.** Advanced problems in modern buildings and building groups with complex requirements. I, II; 2 units. Prerequisite: Architecture 236. STAFF.

338. **Architectural Design.** Terminal project (individual research and comprehensive architectural development). I, II; 2 units. Prerequisite: Architecture 337. STAFF.

339. **Urban Housing.** A study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. II; ½ unit. Prerequisite: Consent of instructor. JONES.

347. **Theory of Structures.** Advanced problems in the analysis of statically determinate structures, and general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. I, II; 1½ units. Prerequisite: Credit or registration in Architecture 247 and Theoretical and Applied Mechanics 211. HORNBEAK.

348. **Advanced Structures.** Advanced topics on design of structural members and connection; analysis and design of continuous structures, rigid frames, and tall buildings. I, II; 1½ units. Prerequisite: Architecture 347; registration in Architecture 358. COY.

358. **Reinforced Concrete Design.** Reinforced concrete building design. I, II; 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348.

ART

The Department of Art offers graduate work leading to the degrees of Master of Fine Arts (painting and printmaking, and design) and Master of Arts (art education and art history). The prerequisite for graduate work leading to these degrees is the Bachelor of Fine Arts degree as established at this University with a concentration in the field to be pursued in graduate study, or its equivalent. Students applying for admission must have a grade-point average of 3.5.

Admission to the Graduate College does not make the student a candidate for an advanced degree in the department until he has been accepted as such by the departmental graduate committee. Upon application to the Graduate College,

information on departmental procedures and requirements should be obtained by writing to the head of the Department of Art. Prospective students expecting to do graduate work leading to the Master of Fine Arts degree must submit original examples of their work to the departmental graduate committee in advance of registration. Students expecting to pursue study leading to the Master of Arts degree in art education must have or be eligible for a teaching certificate in their field. In order to determine eligibility for graduate study, prospective students must submit, for examination, a transcript of their undergraduate credits to the head of the department. In the event that a prospective candidate for any degree in the department is found to be deficient in any professional phase of undergraduate training, the committee will require the student to take such undergraduate courses as will remove the deficiency.

Examinations are held at intervals throughout residence to determine progress and qualifications of degree candidates. These examinations consist of a written examination (given at the time of first registration); a written qualifying examination (given in the latter part of the program); and periodic reviews of studio work in the programs for painting and printmaking, and design. As a result of these examinations, the graduate committee of the department may extend the residence requirement (or increase the total unit requirement) if this seems warranted. The student is recommended for a degree after a final review or examination.

The thesis required for the Master of Fine Arts degree is an original work of creative art, accompanied by a written report, while the thesis for the Master of Arts degree with a major in art history is a written document. The thesis remains the property of the University, as do such other works designated by the departmental graduate committee.

Degree of Master of Fine Arts with Design Major. To qualify for the degree of Master of Fine Arts, with a major in design, each student is required to complete satisfactorily all of the following courses to the minimum of twelve units: Art 491, one to three units; Art 493, one unit; Art 467 or 477, four to six units; art history (two courses elected from the group Art 311 through 320), one and one-half units; art electives (Art 323, 333, 341, 351, 355, 371, 372, 494, and art history), two or three units. A thesis is required.

Degree of Master of Fine Arts with Painting and Printmaking Major. To qualify for the degree of Master of Fine Arts, with a major in painting and printmaking, each student is required to complete satisfactorily all of the following courses to the minimum of twelve units: Art 341, one-half unit (substitution of credit in other courses may be made for this subject by permission of the departmental graduate committee); Art 491, one to three units; Art 493, one unit; Art 495, two to five units; Art 497, two to five units; art history (two courses elected from the group Art 311 through 320), one and one-half units; art electives (Art 323, 351, 371, 372, 494, and art history), one to two units. A thesis is required.

Degree of Master of Arts with Art Education Major. To qualify for the degree of Master of Arts, with a major in art education, each student is required to complete satisfactorily all of the following courses to the minimum of eight units: Art 493, one unit; art history (one course elected from the group Art 311 through 320), three-fourths unit; art electives, two and one-fourth units; Education 311, one-half unit; Education 312, one-half unit; Education 456, one unit; two of the following: Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required.

Degree of Master of Arts with Art History Major. To qualify for the degree of Master of Arts, with a major in art history, each student is required to complete satisfactorily all of the following courses to the minimum of eight units: Art 341, one-half unit; Art 491, one to three units; Art 493, one unit; Art 494, one unit; art history (elected from the group Art 311 through 320), one and one-half to three units; electives, one or two units. A thesis is required.

GRADUATE TEACHING FACULTY

Professors: J. R. Shipley (Head of Department), L. R. Chesney, Jr., C. A. Dietemann, C. V. Donovan, W. F. Doolittle, J. D. Hogan, J. W. Kennedy, E. C. Rae, F. Roos, H. Schultz, A. S. Weller.
Associate Professors: C. W. Briggs, M. B. Martin, M. A. Sprague, N. Ziroli.
Assistant Professors: D. C. Miller, R. Von Neumann.

COURSES FOR GRADUATES

467. **Advertising Design Laboratory.** Individually directed research in the studio with concentration in advertising design. I, II; 1 to 2 units. Prerequisite: Bachelor of Fine Arts degree in advertising design or equivalent. Donovan.

477. **Industrial Design Laboratory.** Individually directed research in the drafting room or workshop with concentration in industrial design. I, II; 1 to 2 units. Prerequisite: Bachelor of Fine Arts degree in industrial design or equivalent. Shipley.

491. **Special Problems.** Individual direction in research and in creative activity; thesis. I, II; 1 to 2 units. Staff.

493. **Seminar.** Introduction to methods of research and criticism. I; 1 unit. Roos, Weller.

494. **Studies in Art History and Criticism.** Individual study of special periods of art history; intensive reading of selected critical works; the writing of art criticism. I, II; 1 to 2 units. Rae, Roos, Weller.

495. **Painting Laboratory.** Professional and experimental painting with emphasis on the development of maturity of style and personal expression. I, II; 1 to 2 units. Staff.

497. **Print Workshop.** Intaglio printing, including etching, engraving, and aquatint. I, II; 1 to 2 units. Chesney.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Classical Art.** Architecture, painting, sculpture, and minor arts of Greece and other ancient civilizations of the Mediterranean area. I or II; ¾ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

312. **Medieval Art.** Architecture, painting, sculpture, and minor arts of the Middle Ages in Europe. I or II; ¾ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

313. **Italian Renaissance Art.** Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. I or II; ¾ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Miller, Weller.

314. **Northern Renaissance Art.** Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. I or II; ¾ unit. Offered in 1961-1962 and in alternate years: Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Miller, Weller.

315. **Art of the Nineteenth Century.** Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. I or II; ¾ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

316. **Art of the Twentieth Century.** Architecture, painting, sculpture, and minor arts of the twentieth century in France, Germany, Spain, and England. I or

II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

317. **American Art.** Architecture, painting, sculpture, and minor arts of the colonies and the United States. I or II; ¾ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Roos.

318. **Latin-American Art.** A study of the more important phases and periods of the visual arts of Latin America. II; ¾ unit. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Rae.

319. **Italian Art of the Seventeenth and Eighteenth Centuries.** An examination of the arts of painting, sculpture, and architecture of the seventeenth and eighteenth centuries in Italy in terms of major figures and dominant stylistic tendencies. I; ¾ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Miller.

320. **Northern European Art of the Seventeenth and Eighteenth Centuries.** An examination of major developments in painting, sculpture, and architecture in the Low Countries, France, Spain, Germany, and England during the seventeenth and eighteenth centuries. II; ¾ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Art 111 and 112 for art students; consent of instructor for others. Miller.

323. **Drawing.** Advanced drawing in several media. I, II; ½ to 1 unit. Prerequisite: Art 126 or equivalent. Staff.

333. **Painting.** Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts degree in painting and printmaking. I, II; ½ to 1 unit. Prerequisite: Art 142 or equivalent. Staff.

341. **Painting Materials and Techniques.** Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. II; ½ unit. Prerequisite: Art 142 or graduate standing in art. Kennedy.

351. **Advanced Sculpture Techniques.** Advanced work in various sculptural media. I, II; ½ to 1 unit. Prerequisite: Art 252 or equivalent. Martin.

355. **Print Media.** Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts degree in painting. I, II; ½ to 1 unit. Prerequisite: Art 256 or equivalent. Chesney.

371. **Silversmithing, I.** Advanced course in design and execution of hollow ware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. I, II; ½ unit. Prerequisite: Art 172 or equivalent. Von Neumann.

372. **Silversmithing, II.** Advanced course in design and execution of flatware and hollow ware, dealing primarily with forging and seaming methods, engraving, and toolmaking. I, II; ½ unit. Prerequisite: Art 371. Von Neumann.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the degrees of Master of Science and of Doctor of Philosophy in Astronomy (including radio astronomy). The admission requirements for graduate study in astronomy are the general regulations governing admission of all graduate students. Applicants must have a grade-point average of at least 3.5. In addition, the entrance requirements are as follows: (1) an undergraduate major in astronomy, mathematics, or physics, or a Bachelor of Science degree in either electrical engineering or engineering physics; and (2) a one-year course in descriptive astronomy.

The eight units for the Master of Science degree may be obtained in three ways, listed as (1), (2), and (3) below. Alternative (3) is intended for students wishing to specialize in radio astronomy.

(1) All eight units may be taken in astronomy; at least three units must be at the 400 level.

(2) Two units may be selected from Mathematics 341, 342, 343, 345, 455, 456, or 459; two units may be taken in Physics 321, 322, 341, 342, 371, 381, 400, 422, 480, or 481; the remaining units must be taken in astronomy. At least three units must be at the 400 level, and at least two of these three units must be taken in astronomy.

(3) Five units may be secured by taking Physics 341, 342, Electrical Engineering 420, 421, and Astronomy 357. The remaining three units must be taken in astronomy; only one of these units need be at the 400 level.

Details regarding the degree of Doctor of Philosophy may be obtained by writing to the head of the department, University of Illinois Observatory, Urbana, Illinois. By arrangement with the University of Chicago, students for this degree may obtain instruction in advanced observational methods in optical astronomy at the Yerkes Observatory, Williams Bay, Wisconsin. Credit so obtained may be transferred to the University of Illinois.

For information regarding applied mathematics, see page 212.

GRADUATE TEACHING FACULTY

Professors: G. C. McVittie (Head of Department), G. W. Swenson, Jr.
Associate Professor: S. P. Wyatt, Jr.
Assistant Professors: I. R. King, A. J. Meadows.

COURSES FOR GRADUATES

404. **Theory of Stellar Structure.** Masses, luminosities, radii, and surface temperatures of stars; basic equations and stability conditions; nuclear reactions; integration of basic equations; results — initial stages, later stages, white dwarfs. I or II; 1 unit. Prerequisite: Consent of instructor. Meadows.

415. **Experimental Methods in Radio Astronomy.** Design and construction of instruments for radio astronomy; techniques of observation of celestial radio sources; interpretation of data. I or II; 1 unit. Reregistration permitted. Prerequisite: Consent of instructor. Swenson.

421. **Dynamics of Stellar Systems.** The observational data; regularities in stellar motions; kinematics of a rotating galaxy; dynamics and mass distributions; stellar encounters; dynamics of star clusters; statistical mechanics of stellar systems; dynamics of the interstellar medium; spiral structure; evolution of galaxies. I or II; 1 unit. Prerequisite: Consent of instructor. King.

424. **Relativity and Cosmology.** Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. McVittie.

464. **Dynamics of the Earth's Atmosphere.** Same as Mathematics 464 and Physics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

491. **Seminar in Special Topics.** I or II; 1 to 4 units. Prerequisite: Consent of instructor. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introductory Astrophysics.** Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interiors; special types of stars, interstellar matter. I or II; 1 unit. Prerequisite: Physics 108. MEADOWS.

306. **Foundations of Mechanics and Gravitational Theory.** Same as Aeronautical Engineering 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to earth, precession of earth's axis, etc. I or II; 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE.

307. **Celestial Mechanics.** Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. I or II; 1 unit. Prerequisite: Astronomy 306 or Physics 322. MCVITTIE.

314. **Observational Astronomy.** Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. I or II; 1 unit. Prerequisite: Astronomy 102 or 210; Mathematics 142 or 143. WYATT.

321. **Galactic Structure.** Observational data on the distribution of stars in space; stellar statistics; stars in solar neighborhood; space-density analyses; galactic rotation; steller populations and their distributions; the form and content of galaxies. I or II; 1 unit. Prerequisite: Astronomy 102 or 210: Mathematics 142 or 143. WYATT.

357. **Radio Astronomy.** Same as Electrical Engineering 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. I or II; 1 unit. Prerequisite: Physics 108. SWENSON, WYATT.

BIOLOGICAL SCIENCES

Master of Science in the Biological Sciences. The School of Life Sciences (botany, entomology, microbiology, physiology, and zoology) sponsors a program leading to the degree of Master of Science in the Biological Sciences. Students seeking admission must have a grade-point average of at least 3.5.

In order that candidates may acquire a broad training in biology without too early specialization, they must take a minimum of one unit in each of the following: botany, entomology, microbiology, physiology, and zoology. Of the eight units required for the degree, at least one unit must be taken in courses open only to graduate students (400 level). A thesis is not required, but at least one course should be included in which individual problems are assigned. An oral examination, administered by a committee appointed by the student's adviser, is required of all candidates for the degree. In planning a course of study it is recommended that less emphasis be given to areas in which the individual has already had considerable training. Students interested in experimental biology as a career are urged to acquire basic training in the physical sciences and to study toward the Ph.D. in an area of primary interest. The adviser for candidates for this degree is Professor A. B. Taylor, 435 Burrill Hall, who will answer any inquiries about it.

Master of Science in the Teaching of the Biological Sciences and General Science. This degree is offered with the completion of the fifth year in the teacher training curriculum in biological and general science. The degree is pri-

marily intended for but not restricted to certificated teachers of biology and general science in junior high school, high school, and junior colleges. For admission to this degree students must have a grade-point average of at least 3.5.

Candidates for the degree of Master of Science in the Teaching of the Biological Sciences and General Science must earn four units in biological sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in the biological sciences and the electives must be selected with the approval of the adviser. The electives may be in the biological sciences, in education, or, in exceptional cases, in other fields. A course in biological chemistry and one in experimental psychology are strongly advised. The adviser for candidates for this degree is Professor W. N. Stewart, 206 Natural History Building.

Students wishing to combine training for research in biology with graduate work in physics and chemistry may be interested in one of the curricula in biophysics listed below.

BIOPHYSICS AND BIOPHYSICAL CHEMISTRY (MOLECULAR BIOLOGY)

Biophysics is a rapidly growing field that cuts across many disciplines. An area overlapping with this and developing through interaction of chemistry and biology is that of biophysical chemistry.

Since graduate study in biophysics and biophysical chemistry involves several areas of biological and physical science, the Graduate College has adopted a flexible system enabling students to enter special interdisciplinary programs in these areas, thus affording the student a wide range of opportunity for study and research in borderlands between the biological and physical sciences.

A program leading to the degree of Doctor of Philosophy in Biophysics is offered by the Biophysical Division of the Department of Physiology (see page 253). Students majoring in chemistry or microbiology may elect to specialize in biological problems at the molecular level (see page 217). Students in other areas of the biological and physical sciences who wish to arrange programs of study emphasizing biophysics should direct their inquiries to the head of the major department.

BOTANY

The Department of Botany offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. Candidates for advanced degrees must have had at least twenty hours of undergraduate work in botany, or fifteen hours in botany and five hours in a related subject acceptable to the department. Admission to graduate work in the department is contingent upon satisfaction of admission requirements of the Graduate College which are described in the general introductory section of this catalog. Specifically, the applicant's grade-point average must be at least 3.75.

The following fields of botany are available for specialization within the department: anatomy, cytogenetics, cytotaxonomy, ecology, mycology, paleobotany (including palynology), phycology, physiological genetics, physiology (including photosynthesis), plant geography, taxonomy, and virology.

Attention is called to courses offered in the Departments of Agronomy, Chemistry, Entomology, Geography, Geology, Horticulture, Mathematics, Microbiology, Physics, Physiology, Plant Pathology, and Zoology, which are available

to advanced students and offer a broad foundation for botanical work. Graduate students in botany may elect their minor subjects in one or two of these fields.

Graduate students may avail themselves of the University herbarium which contains 500,000 specimens of vascular plants, bryophytes, algae, fungi, and fossil plants. As field laboratories, the University maintains two tracts of woodland, Brownfield Woods and Trelease Woods; in addition, certain areas of Robert Allerton Park near Monticello have been designated for research and study. Several ranges of greenhouses are maintained for experimental work with living plants, and laboratories well equipped for research in plant physiology, genetics, mycology, photosynthesis, paleobotany, and plant virology, are available to students in these fields. The Maize Genetics Research Laboratory maintains an extensive collection of maize genetic stocks adapted to the North Central states; the College of Agriculture and the Agricultural Experiment Station offer exceptional facilities to graduate students in plant genetics, plant pathology, and in some others of the plant sciences. The Natural History Library, with over 70,000 volumes, offers excellent library facilities, with bibliographical aids including the Gray Herbarium Card Index of American Plants, the Index of American Botanical Literature of the Torrey Botanical Club, and the Tilden Index Algarum Universalis. The University also maintains such facilities as electron microscopes, electronic computer, betatron, ultracentrifuge, and a radiocarbon laboratory for use in tracer studies.

Degree of Master of Science. During their graduate work or as advanced undergraduates, candidates for this degree must have completed courses in the following basic fields of botany: (1) taxonomy (Botany 460 or equivalent), (2) morphology (Botany 302 and 303, or equivalent), (3) ecology or plant geography (Botany 381, or 385 or 386, or equivalent), (4) genetics (Botany 322 or equivalent), (5) physiology (Botany 130 or equivalent).

A thesis is not required of candidates for the Master of Science degree except at the option of the graduate student's major adviser. Graduate students do not receive credit in research courses toward the master's degree unless they write acceptable master's theses. The master's degree is not prerequisite to work toward the doctorate; that is, a student may engage in graduate work toward the Doctor of Philosophy degree without having obtained a master's degree.

Degree of Doctor of Philosophy. Candidates for this degree must complete the course requirements listed above before receiving the Doctor of Philosophy degree. Students who commence their graduate work at the University of Illinois ordinarily complete these requirements during their first year of graduate study. Students who enter upon graduate work toward the doctor's degree at the University of Illinois after having received the master's degree from some other university, or after having completed some graduate work at another university, are required to complete any of the above-listed courses which they may not have had. Having satisfied these basic course requirements, the candidate for the doctor's degree may elect whatever other graduate courses he desires, subject to the approval of his major professor and to the general regulations of the Graduate College concerning requirements in his major and minor fields (see the general introductory section of this catalog).

All candidates for the Doctor of Philosophy degree in botany must pass a qualifying examination in the above-listed basic fields of botany, the purpose of which is to determine whether the student is qualified to pursue further work toward the degree and to provide a basis for recommending a program of study in those areas in which he may be deficient. This examination is administered as a written examination to be taken by all doctorate candidates within one year after initiation of their studies at the University of Illinois. Qualifying examinations are given in the fall and in the spring in accordance with a schedule set by the botany faculty.

Master's and doctor's theses are due in the office of the Department of Botany ten days before they are due in the Graduate College Office. During this period theses are available for reading by faculty members who may suggest changes in them before they are delivered to the Dean of the Graduate College. Graduate theses must be prepared in accordance with "Instructions for Preparation of Theses," a publication available in the Graduate College Office.

Students desiring to obtain a master's degree preparatory to high school teaching should register in the graduate teacher-training curriculum leading to the Master of Science degree in the Teaching of the Biological Sciences and General Science (see page 65). The adviser for candidates for this degree is Professor W. N. Stewart, 206 Natural History Building.

Opportunities for biophysical research are available in the Botany Department in an interdepartmental curriculum leading to the degree of Doctor of Philosophy in Biophysics, and requiring a combined training in physics, chemistry, and biology.

GRADUATE TEACHING FACULTY

Professors: W. N. Stewart (Chairman of Department), L. M. Black, H. J. Fuller, J. B. Hanson, G. N. Jones, J. R. Laughnan, E. I. Rabinowitch, D. P. Rogers.

Associate Professors: R. M. Kosanke, J. F. Nance, P. C. Silva.

Assistant Professors: L. C. Bliss, D. M. Post.

COURSES FOR GRADUATES

402. **Physiological Genetics.** The probable nature of the gene and its action as deduced from studies on chromosome chemistry, genetically controlled reactions, cytoplasmic inheritance, mutation and gene analogues, with emphasis on higher plants and fungi. II; ½ or 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Botany 322 or equivalent. Laughnan.

403. **Physiology of Fungi.** Same as Plant Pathology 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. I; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Organic or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

410. **Botanical Discussions.** Attendance is required of all graduate students with majors in botany and each is required to give one seminar (¼ unit) a year except in his first year. Total credits not less than ½ nor more than 1 unit. I, II; 0 to ¼ unit.

411. **Discussions in Genetics and Cytogenetics.** Same as Zoology 411. I, II; ¼ unit. Kitzmiller, Laughnan, Luce.

413. **Discussions in Plant Physiology.** I; ¼ unit. Nance.

414. **Discussions in Plant Morphology and Taxonomy.** I; ¼ unit. Jones, Post, Silva, Stewart.

418. **Discussions in Plant Ecology and Plant Geography.** Developments in ecology and plant geography, with emphasis on one special division. I; ¼ unit. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. Bliss.

419. **Discussions in Photosynthesis and Related Topics.** I, II; ¼ unit. Prerequisite: Consent of instructor. Rabinowitch.

420. **Cytology.** Study of nuclear and cell division, with emphasis on chromosome structure and behavior. Various aspects of cytological behavior are con-

sidered in relation to genetics and development. I; 1 unit. Prerequisite: One year of botany. STAFF.

421. **Cytogenetics.** An advanced course in which emphasis is placed on the correlation of genetic data with chromosomal aberrations. II; 1 unit. Prerequisite: Botany 420 and 322, or equivalent. STAFF.

424. **Mineral Nutrition of Plants.** Same as Agronomy 424 and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. II; 1 unit. Prerequisite: Botany 130 or consent of instructor. HAGEMAN.

427. **Discussions in Mycology.** A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. I, II; ¼ unit. Prerequisite: Consent of instructor. ROGERS.

428. **Palynology.** Same as Geology 428. The study of pollen and other spores, with emphasis on their evolution, paleoecological significance, stratigraphic application, and methods of preparation for study. I; ½ to 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Botany 120 or Geology 101, or consent of instructor. KOSANKE.

433. **Advanced Physiology of Growth, Responses, and Reproduction.** I; 1 unit. Prerequisite: Botany 130 or equivalent. HANSON.

435. **Plant Physiology: Metabolic Transformations.** II; ½ or 1 unit. Prerequisite: One year of botany, including Botany 130; one year of chemistry. NANCE.

450. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology of algae. II; ½ or 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. SILVA.

460. **Advanced Taxonomy of Flowering Plants, I.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. I; ½ or 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Botany 160 or one year of botany or another biological science, or consent of instructor. JONES.

461. **Advanced Taxonomy of Flowering Plants, II.** The application of cytology, ecology, genetics, and morphological analyses to the study of evolution and the natural relationships of populations as exemplified by species of higher plants. II; ½ or 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Botany 160 and 322 or equivalent. Consent of instructor. STAFF.

471. **Advanced Mycology: Special Groups.** Special groups of fungi and their activities are considered. Different groups for concentrated study may be selected each semester depending upon the student's interest in mycology. I, II; ½ unit. Prerequisite: Consent of instructor. ROGERS.

472. **Industrial Mycology.** The characteristics, relationships, and activities of fungi of industrial importance are considered. Yeasts and mushrooms are included but major emphasis is placed on Mucorales, Aspergilli, Penicillia, and Fungi Imperfecti. I; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Consent of instructor. ROGERS.

493. **Advanced Studies in Botany.** I, II. ½ to 2 units. Not more than one unit may be applied toward the Graduate College master's degree requirement of 3 units of course work at the 400 level. Work may be taken in the following fields:

(a) Anatomy — Plant. Post.
(b) Cytogenetics. Staff.
(c) Cytology. Staff.
(d) Ecology — Plant. Bliss.
(e) Genetics — Plant. Laughnan.
(f) Morphology — Higher Vascular Plants.
(g) Morphology — Primitive Vascular Plants. Stewart.
(h) Mycology. Rogers.
(i) Paleobotany. Kosanke, Stewart.
(j) Photosynthesis. Rabinowitch.
(k) Phycology. Silva.
(l) Physiology — Plant. Hanson, Nance.
(m) Taxonomy of Bryophytes. Jones.
(n) Taxonomy of Vascular Plants. Jones.
(o) Virology — Plant. Black.

499. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Individual Topics.** For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degree. I, II; ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. Staff.

301. **Plant Pathology.** Same as Plant Pathology 301. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science, including Botany 100. Black.

302. **Comparative Morphology: Nonvascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, and bryophytes. Students receiving credit for Botany 302 do not receive credit for Botany 304. I; ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. Rogers, Silva, Stewart.

303. **Comparative Morphology: Vascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative vascular plants, including psilopsids, lycopsids, sphenopsids, ferns, gymnosperms, and angiosperms. Students receiving credit for Botany 303 do not receive credit for Botany 304. II; ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. Post, Stewart.

304. **General Plant Morphology.** A survey of the principles of plant morphology as exemplified by the various plant groups. Designed primarily for high school and college teachers who are summer session students. Students receiving credit for Botany 304 do not receive credit for Botany 302 or 303. S; ½ or 1 unit. Offered in 1960 and in alternate years. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent.

306. **Biology for Teachers.** Same as Zoology 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. This course adjusted to professional semester (practice teaching) for students in teacher-training curriculum. Two four-hour field trips to be given on Saturday. II; ½ unit. Prerequisite: Botany 100 and Zoology 101 or 104, or a year course in general biology. Matteson.

322. **Genetics.** A basic treatment of the facts and fundamental principles of

genetics, with special emphasis on plants. I; 1 unit. Prerequisite: One year of botany. LAUGHNAN.

325. **Paleobotany.** Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. II; ½ or 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor. STEWART.

340. **Histological Technique.** Survey of techniques used in the preparation of tissues for microscopical examination. II; 1 unit. Prerequisite: One year of botany or ten hours of zoology, or consent of instructor. POST.

341. **Field Ecology.** Study of the plant communities at Mammoth Cave and Great Smoky Mountains National Parks covering seven days over spring vacation. Outdoor camping and cooking. Transportation in University cars. Deposit of $20.00 required. Total cost about $35.00. II; ¼ unit. Prerequisite: One course from the following — Botany 160, 366, 381, or 385. BLISS.

345. **Plant Anatomy.** Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. I; ½ or 1 unit. Prerequisite: One year of botany. POST.

366. **Field Botany.** Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. JONES.

372. **General Mycology.** Structure, classification, and identification of fungi, including those of economic importance. II; 1 unit. Prerequisite: One year of botany, bacteriology, entomology, or zoology. ROGERS.

381. **Plant Ecology.** Principles of ecology, exemplified by vegetation and environments of Illinois. I; ½ to ¾ unit. Prerequisite: One year of botany. BLISS.

382. **Ecological Methods.** Field methods used in plant ecology. II; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: One year of botany including Botany 381 or equivalent. BLISS.

385. **Plant Geography of North America.** Vegetation regions and principal subdivisions; environments, plant cover, floras. II; ½ or 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: One year of botany. BLISS.

386. **Plant Geography of Continents Other Than North America.** Regions, vegetation-types, notable species. I or II; ½ or 1 unit. Prerequisite: One year of botany. BLISS.

BUSINESS

The degree of Doctor of Philosophy in Business is awarded to those who complete the subject-matter requirements listed below and the general requirements named in the first section of this catalog. The subject-matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Students lacking adequate preparation for admission may be admitted with the consent of the adviser or committee in charge, but must remove any deficiencies during the first year of residence by taking prescribed courses without credit toward the advanced degree. Those candidates who hold a master's degree in economics or business can usually

complete the requirements in two years by appropriate synchronization of courses previously taken with those offered in this program.

In lieu of the provisions on major and minor subjects on page 21, candidates for the Doctor of Philosophy degree in Business prepare themselves for examination in five fields, including management, marketing, and economic theory. At least two other fields must be selected, one of which (two units) may be outside the College of Commerce and Business Administration if approved by the adviser. For numbers and titles of courses available, see the courses listed in this catalog under Accountancy, Business Education, Economics, Finance, Management, and Marketing.

Inasmuch as the major fields for this degree cross departmental lines, administration of the work is in the hands of a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the Executive Secretary of the Committee on the Doctor of Philosophy Degree in Business, 411 David Kinley Hall.

COURSES FOR GRADUATES

499. **Thesis Research.** I, II; 0 to 4 units.

BUSINESS ADMINISTRATION

The Graduate School of Business Administration offers professional programs leading to the degrees of Master of Business Administration, Master of Commerce, Master of Accounting Science, and Doctor of Business Administration. Students applying for admission must have a bachelor's degree with a 3.5 grade average in the last sixty hours of work.

The Admission Test for Graduate Study in Business is required. There is a $10.00 fee for this test. The examination is given in many centers in the United States and abroad in November, February, April, and July. Test applications and information may be obtained from: Admission Test for Graduate Study in Business, Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. The application form and fee must be received in Princeton at least two weeks before the test date.

Degree of Master of Business Administration. Applicants who hold a bachelor's degree from an accredited college or university may be admitted regardless of the undergraduate field of study. More attention is given to the quality of the work and the promise of satisfactory scholastic and administrative performance as indicated by the undergraduate record than to the particular subject matter studied.

Candidates for the degree of Master of Business Administration must complete a minimum of sixteen units (sixty-four semester hours) of work, normally requiring residence of two years or four semesters. A 4.0 grade average is required for graduation. Students are admitted only in September.

Degree of Master of Commerce. The applicant must have a bachelor's degree in economics or business. Candidates with sufficient undergraduate background in production, control, marketing, finance, and economics may meet the requirements for the degree by completing eight units (thirty-two semester hours) of course work. Candidates are required to take a comprehensive examination when all course requirements have been completed.

Degree of Doctor of Business Administration. (1) Eight or more units of professional courses beyond the appropriate master's degree are required, depending upon the extent of the student's previous preparation in the functional areas of business administration. Candidates with one-year master's degrees should

expect to take more than eight units of work. (2) Upon completion of the course work the candidate is required to take a comprehensive examination. (3) The student must complete a thesis which demonstrates his capacity to do independent research. The thesis requires field investigation.

Degree of Master of Accounting Science. For details of this program, see Accountancy, page 33.

Additional information concerning the requirements of the various degree programs may be obtained from the Director of the Graduate School of Business Administration, 214 David Kinley Hall.

GRADUATE TEACHING FACULTY

See faculties of Departments of Accountancy, Economics, Finance, Management, and Marketing.

PROFESSIONAL COURSES

501. **Business Economics.** Analysis of supply and demand functions in an uncertain environment; practical applications of economics to the management of business enterprise; the firm's place in the economic system; the place of the enterprise in national accounts. Case materials are used. I; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

502. **Managerial Economics.** Monetary and national income analyses essential to understanding governmental policies directed to macro-economic goals; the impact of such policies on the individual business firm and on decision-making by business management; the responsibilities of the individual business firm in contributing to the attainment of social goals of a macro-economic nature; the role of the business leader in formulating public policy in the macro-economic area. I, II; 1 unit. Prerequisite: Registration in the Graduate School of Business Administration.

510. **Administrative Behavior.** This course covers (1) an introductory knowledge and understanding of the role of the administrator in interaction with his superiors, associates, and staff; theories of leadership or organization; motivation; individual and group behavior; and community responsibility; (2) administrative skill in communication, counseling, decision-making, introducing improvements, and training. II; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

511. **Production, I.** This course is intended to give the student a knowledge of basic manufacturing methods and production management, and to develop his ability to analyze and solve production problems. The course first covers the technical aspects of production, blueprints, interpretation of engineering information, manufacturing processes, cost considerations of alternate methods of manufacturing, and decisions as to whether to make or buy. The course then considers the managerial aspects of efficient production through the use of methods study, motion study, time study, and plant layout. I; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

512. **Production, II.** A continuation of Business Administration 511. Emphasis is given to methods available for operating a manufacturing plant in a coordinated fashion in order to meet the objectives of management. Included are control of labor costs, production and inventory control, and quality control. The last portion of the course covers some of the newer developments in production and how these developments influence or relate to the previously covered topics. II; ¾ unit. Prerequisite: Registration in Graduate School of Business Administration.

513. **Executive Policy-Making and Planning, I.** A course on policy construction at the executive level and the planning aspects of policy implementation. An important purpose of the course is to build a general management point of view (as distinguished from an orientation toward a department or specialty); this is accomplished by studying company-wide situations from the vantage point of the chief executive. Case method study with supporting readings. Develops integration and application of the subject matter of prior courses. I; ¾ unit. Prerequisite: First-year Master of Business Administration courses or equivalent.

514. **Executive Policy-Making and Planning, II.** In this course, which continues the work of Business Administration 513, emphasis is shifted to student-team studies of actual industry and company policy-construction situations. Case method study continues but shares the course time with oral and written reports based on library research. II; ¾ unit. Prerequisite: Business Administration 513.

521. **Marketing, I.** This course is concerned with an analysis of executive decisions and policies about marketing situations, especially those relative to marketing channels, physical handling, transfer of ownership, institutions, products, price, merchandising, sales and advertising promotion, research, and experimentation. I; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

522. **Marketing, II.** Involves a study of making executive decisions relating to the selection and use of market measurement and control devices, especially those relating to geographical definition of markets and control units, marketing opportunity, marketing cost analysis, sales and cost control, and marketing policy alternatives suggested by the analysis. II; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

530. **American Business History.** The historical development of methods used in the various aspects of business administration as it relates to the changing environment. Students are given the opportunity to study how individual firms have adjusted to existing conditions in the formulation of policies. Included are the business careers, methods, and contributions of famous business leaders from Revolutionary War days to the present. II; 1 unit. Prerequisite: Two semesters of graduate work in business administration.

531. **Legal Problems of Business Management.** The course is designed to acquaint the student with past and current development of the legal climate in which business operates and in which managerial decisions are made. A study is made of the growth of the common law with its system of courts and the procedure for law enforcement. The law of contracts, which is basic to all business transactions, is examined, including various devices available for protection of creditors. Legal problems involved in selecting a form of business organization are analyzed. Consideration is given to both the common and statutory law that prohibits certain business practices thought to be injurious to the welfare of society and to business in general. Through the use of legal and business case material, students are given an opportunity to analyze business problems and to see the importance of proper applications of the law to managerial decisions in regard to business policies. I; 1 unit. Prerequisite: Registration in the Graduate School of Business Administration.

541. **Managerial Accounting and Control.** An analysis of managerial controls, the information needed for their operation, and the manner in which accounting provides that information; emphasis upon accounting as a tool of management. Problems and cases stress the type of figure information relevant to managerial decisions, and the methods of using such data. I; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

542. **Industrial Cost Control.** A study of cost accounting, with emphasis on the use of operating data by management for control purposes. Methods of material pricing, labor costs, including fringe benefits; indirect manufacturing costs, direct costing, standard costs; estimated and statistical costs; distribution costs; contribution to overhead theory; depreciation and replacement of equipment; selection of plant; decision to make or buy; relation between costs and pricing policy. I; 1 unit. Prerequisite: Business Administration 541 or equivalent.

543. **Financial and Interpretive Accounting.** A study of financial statements, including supplementary financial information essential to business management, with primary emphasis on analysis and interpretation. Designed to give students an understanding of the nature, significance, and interrelationships of accounting statements, terms, and data. Analysis of relationship of accounting financial information to management's financial decisions, and accounting and management problems caused by price level changes. II; 1 unit. Prerequisite: Business Administration 541 or equivalent.

544. **Controllership.** The controller in the business organization: his property control responsibilities; internal check; internal audits; insurance; his assistance to operating management through budgeting, break-even analysis, profitability studies; his relationship with groups outside of management such as investors and government agencies; emphasis on manner in which figure function of controller is used to integrate the operations of the business enterprise. II; 1 unit. Prerequisite: Business Administration 542 or equivalent.

554. **Financial Analysis.** The course is designed to develop the student's awareness of and ability to cope with problems of financial management encountered in the organization and operation of a business enterprise. Attention is centered on the relationship of financial management to the other aspects of business administration. The course considers the nature and sources of short- and long-term funds and an analysis of the capital markets; the methods and techniques of financial analysis, both internal and external; and the determination and management of the cash budget. I; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

555. **Financial Policy.** The course is designed to acquaint the student with the short- and long-range aspects of financial administration and policy formulation. The regulatory framework which affects business financial policy is explored and related to individual business situations and decisions. The determination and management of the capital budget, including cost of capital, return on investment, and stockholders' expectations, are considered. Financial aspects and problems in valuation, mergers, consolidations, and reorganizations are analyzed and related to other aspects of such programs. Special current problems in financial policy and management are studied. II; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

571. **Statistical Controls for Business.** An introduction to probability and nonprobability topics in statistical analysis and decision-making under uncertainty as applied to business firms. Description statistics, regression, linear programming, waiting lines, sampling surveys, quality control, and Monte Carlo methods are covered. II; ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

580. **Written Analysis of Cases.** This course is designed to develop the student's capacity to write reports based upon his analysis of cases and the conclusions reached. Skills of analysis and decision-making that are necessary to effective executive management are stressed. However, both the writing and the

analytical methods are varied because the cases cover all aspects of business administration. The course is administered by members of the staff concerned with writing and with the principal areas of business organization and operations. I; ½ unit. Prerequisite: Registration in the Graduate School of Business Administration.

581. **Written Analysis of Cases.** This course is staff-administered. The combination of classroom study of business conditions and personal visits to business firms is utilized for the solving and written reporting of business problems. Visits to businesses are made to select problems for analysis. Written reports of the problems, analyses, and decisions are the bases for further developing the student's capacity in written communications. II; ½ unit. Prerequisite: Registration in the Graduate School of Business Administration.

599. **Thesis Research.** Individual direction of research and thesis writing. I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

373. **Electronic Data Processing for Business.** A course in the fundamentals of business data processing. The use of modern electronic computers in the areas of accountancy, economics, management, marketing, and general business is considered. The facilities of the Digital Computer Laboratory are utilized in the course. I, II; ½ to 1 unit. Prerequisite: Economics 170; Accountancy 106 or 108. SCHLOSSER, YANCEY, and others.

BUSINESS EDUCATION

The Department of Business Education offers graduate work leading to the degree of Master of Science in Commercial Teaching. The work is part of an integrated five-year program for those preparing to became commercial teachers. The requirements of the fifth year are based on the educational background of the first four years. Students may also take advanced degree programs in education specializing in business education.

Students seeking admission in any area must have a grade-point average of 3.5. Only a limited number of the requirements listed below may be completed by extramural graduate study. Questions related to extramural courses should be referred to the appropriate graduate adviser.

Candidates for the degree of Master of Science in Commercial Teaching must earn three units in education, as described in Group 1 below; three units in commerce, consisting of two units from courses listed in Group 2 below and one unit from courses listed in Group 3 below (business education); and two units of electives. All courses must be selected with the approval of the student's adviser.

(1) Education. Three units consisting of Education 311, 312, 456, and two of the following: Education 301, 302, 303, 304.

(2) Commerce (other than business education). Two units selected from Accountancy 308, 371, 401; Business Law 301; Economics 326, 328, 384, 400, 414, 415, 436, 440, 441; Management 312; Marketing 315, 372, 373, 387, 401, 415, 421, 481.

(3) Commerce (business education). One unit selected from Business Education 351, 352, 353, 361, 382, 383, 491.

(4) Recommended electives. Two units selected from courses listed under (1) and (2), or not more than one unit from (3), or from courses in the following list: Education 354, 381, 390, 391, 401, 411, 413, 422, 423, 425, 428, 439, 460; Journalism 308. Other courses may be taken with the consent of the adviser.

The adviser for candidates for this degree is Professor Arnold C. Condon, 9 David Kinley Hall.

GRADUATE TEACHING FACULTY

Professor: A. C. Condon (Head of Department).
Associate Professors: F. L. Crank, Elizabeth R. Melson.
Assistant Professors: R. E. Mason, Mildred E. Reed.

COURSES FOR GRADUATES

499. Thesis Research. I, II; ½ to 2 units. Condon.

Note: See also Education 456 and 459.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. Improvement of Instruction in Shorthand. A study of the history, principles, and practices of shorthand instruction, including evaluation of literature, research, and methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including Business Education 112; sixteen hours in education, including Education 242. Condon, Reed.

352. Improvement of Instruction in Typewriting. A study of the history, principles, and practices of typewriting instruction, including evaluation of literature, research, and of methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including Business Education 203; sixteen hours in education, including Education 242. Melson, Reed.

353. Improvement of Instruction in Bookkeeping. A study of the history, principles, and practices of bookkeeping instruction, including evaluation of literature, research, and methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every fifth semester, S; ½ unit. Prerequisite: Sixteen hours in commerce, including six hours in accountancy; sixteen hours in education, including Education 242. Mason.

361. Teaching Office Management and Machine Operations. Designed for high school and college teachers. Selection and use of machines, course content for machine courses, and organization of instructional material. S; ½ unit. Prerequisite: Education 241, 242; sixteen hours in commerce, six of which must be in accountancy; one year of teaching experience. Melson.

382. Organization and Administration of Cooperative Part-Time Programs in Business Education. Deals with background, aims, coordination techniques, and administrative policies for organizing and operating cooperative part-time programs in distributive and office occupations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce; consent of instructor. Mason.

383. Problems in Cooperative Education. Students apply for and secure distributive or office positions with selected cooperating business firms. While regularly employed in these supervised positions, they observe the relationships between those activities and the cooperative business education programs in the high school. These relationships are pointed up through regularly scheduled class meetings where emphasis is placed on job analysis, current trends, wage and benefit structure, personnel practices, and labor relations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce. Mason.

BUSINESS LAW

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE TEACHING FACULTY

Professors: E. R. Dillavou (Head of Department), P. C. Roberts.
Associate Professor: B. F. Kirkpatrick.
Assistant Professor: R. N. Corley.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Business Torts.** Liability of businessmen for their wrongful acts and those of their agents arising separate and apart from their liabilities under contracts; covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, inducing breach of contract. II; ¾ to 1 unit. Prerequisite: Business Law 100 or credit or registration in Business Law 202. Kirkpatrick.

301. **The Law of Security Transactions and Banking.** Significant phases of law in the fields of pledges, chattel mortgages, conditional sales, suretyship, insurance, real property, banks and banking, and bankruptcy. Under real property, real estate mortgages, landlord and tenant and mechanics liens are considered as well as the general principles of real property. I, II; ¾ to 1 unit. Prerequisite: Business Law 100 or credit or registration in Business Law 202. Roberts.

302. **Wills, Estates, and Trusts.** A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. I; ¾ to 1 unit. Prerequisite: Business Law 100 or credit or registration in Business Law 202. Corley.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers graduate work leading to the degrees of Master of Science in Ceramics, Master of Science in Ceramic Engineering, Doctor of Philosophy in Ceramics, and Doctor of Philosophy in Engineering.

The prerequisite for a major in graduate work in ceramics or ceramic engineering is proficiency in the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired, or substantial equivalents. An applicant must have a grade-point average of at least 3.5 for the last sixty hours of work.

Candidates for the degree of Doctor of Philosophy in Ceramics must have had the equivalent of at least twenty-five semester hours of satisfactory courses in general, analytical, physical, and organic chemistry; also calculus, one year of college physics, and at least eighteen semester hours or their equivalent in acceptable ceramic courses.

Students with bachelor's degrees in chemistry, physics, or engineering may become candidates for the Master of Science or Doctor of Philosophy degrees but must make up deficiencies in ceramics. The student must always be registered in at least one unit of graduate work.

The fields for majoring in ceramics or ceramic engineering are refractories and high temperature materials, porcelain enamels, glass, whitewares, structural clay products, electrical solid state and nuclear ceramics, and materials. The most common minors selected by graduate students in ceramic engineering are chemistry, physics, metallurgy, mathematics, geology, and engineering.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramic prerequisite.

GRADUATE TEACHING FACULTY

Professors: A. I. Andrews (Head of Department), A. W. Allen, R. L. Cook, A. L. Friedberg, F. V. Tooley.
Assistant Professors: R. J. Beals, J. A. Nelson.

COURSES FOR GRADUATES

401. **Ceramic Chemistry.** Silica, silicates, fusions, and phase relations. I; 1 unit. Prerequisite: Courses in chemistry and physics. Andrews.

402. **Ceramics.** Chemical and physical phenomena. II; 1 to 2 units. Prerequisite: Courses in physics and chemistry. Andrews.

405. **Glass Technology.** This course, following a brief review of unit processes and operations in glass manufacture, treats from a dominantly theoretical and research point of view selected major topics relating to the glass preparation process and the chemical, mechanical, optical, and electrical properties of glass. I; ¾ unit. Prerequisite: Ceramic Engineering 301 or equivalent, or consent of instructor. Tooley.

406. **Glass Technology.** This course is dominantly theoretical in approach. Following a survey of the basic theoretical ideas that have been used in the development of the glass model, student readings and reports from the classical and modern literature serve as the basis of class discussions on glass structure and behavior, with emphasis on structure property correlations. II; ¾ unit. Prerequisite: Ceramic Engineering 405 or consent of instructor. Tooley.

407. **Porcelain Enamels.** This course covers the fundamental scientific principles involved in the area of porcelain enameling and the properties of such coatings. I or II; 1 or 1½ units (includes laboratory if taken for more than 1 unit). Prerequisite: Ceramic Engineering 222 and 320, or equivalent. Andrews.

409. **Whitewares.** Advanced study in the field of whitewares, including fundamental considerations of glazes and all types of ceramic bodies. Special emphasis is placed on new developments in research and processing. Considerable attention is given to the ferroelectric and ferromagnetic properties of electronic ceramics. I; 1 to 1½ units (includes laboratory if taken for more than 1 unit). Prerequisite: Ceramic Engineering 209; Ceramic Engineering 340 or equivalent. Cook.

412. **Structural Physical Ceramics.** Structural chemistry and crystallization behavior of ceramic systems at elevated temperatures; nucleation, crystal growth; mineral synthesis; high-temperature reaction kinetics, including phase transformations and diffusion. II; ¾ unit. Friedberg.

413. **Research Analysis.** Design of ceramic experiments and analysis of experimental data; applications of statistical analysis and measurement theory; graphical representation of data. I; ½ unit. Friedberg.

421. **High Temperature Technology.** A review of the methods of achieving and controlling high temperatures, both in industrial processes and in the laboratory, combined with a study of the techniques for measuring the properties of materials at elevated temperatures emphasizing oxides, carbon and graphite, silicates, carbides, borides, silicides, nitrides, sulfides, cermets, and refractory metals. A correlation of the physical and chemical behavior of these materials with their crystal structure, microstructure and physical form

is emphasized where possible. I; ¾ unit. Prerequisite: Ceramic Engineering 310. ALLEN.

422. **High Temperature Technology Laboratory.** Laboratory to accompany Ceramic Engineering 421, with emphasis on instrumentation for and measurement of properties at elevated temperature. Analytical interpretation of data in numerical problems is included. I or II; ½ unit. Prerequisite: Credit or registration in Ceramic Engineering 421, or consent of instructor. ALLEN.

495. **Materials and Special Problems.** Conference and laboratory. I or II; 1 to 2 units. ALLEN, ANDREWS, BEALS, COOK, FRIEDBERG, TOOLEY.

499. **Thesis Research.** Research in any of the branches of ceramics. I, II; 0 to 4 units. ALLEN, ANDREWS, BEALS, COOK, FRIEDBERG, TOOLEY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Glass Technology.** This course augments some of the subject matter of Ceramic Engineering 214, and develops additional subject matter relating to the theory of glass formation and structure and the behavior of glass as a function of composition, structure, and heat treatment. Students taking this course gain improved qualifications for research work in the field. I; ½ unit. Prerequisite: Ceramic Engineering 214 or consent of instructor. TOOLEY.

310. **Refractory Technology.** A study of the engineering properties and thermochemistry of polycrystalline materials for use at elevated temperatures, including processing of raw materials, the manufacture, heat treatment, quality control, and specification of refractory products. Particular emphasis is placed on oxides, silicates, carbides, borides, cermets, and refractory metals, with a correlation of the properties of those materials to certain design criteria. II; ¾ to 1 unit (includes laboratory if taken for 1 unit). Prerequisite: Senior standing in engineering. ALLEN.

320. **Advanced Porcelain Enamels.** An advanced study of the field of porcelain enamels with particular emphasis on fundamentals of bond or adherence of enamel metal systems, on opacity and mechanism of color development and measurement, and on the thermal and chemical properties of coatings on metal. Specific attention is given to coatings for use on metals at elevated temperatures. II; ½ unit. Prerequisite: Ceramic Engineering 222 or consent of instructor. COOK.

331. **Ceramic Microscopy.** A study of the optical activity in isotropic and anisotropic media with particular emphasis on the materials and products of ceramics; the application of these principles and related topics of optical microscopy to the study of the morphology, aggregation, size, and microstructure of the products of high-temperature thermochemical reactions and equilibria. I, II; ¾ to 1 unit (includes studies in thermal microscopy if taken for 1 unit). Prerequisite: Ceramic Engineering 205; Ceramic Engineering 206; or consent of instructor. ALLEN.

340. **Electrical Ceramics.** Special emphasis is given to the electrical properties and requirements of ceramics for use at normal and high frequencies. Fundamental structural consideration in the development of ferroelectric and ferromagnetic properties of ceramics is covered in considerable detail. Glass to metal and ceramic to metal seals, as well as ceramics for use in elevated temperature electrical circuitry are presented. II; ½ unit. Prerequisite: Ceramic Engineering 209 or consent of instructor. COOK.

CHEMICAL PHYSICS

Fundamental research on many properties of molecular and solid state systems is based on an understanding of chemistry, physics, and mathematics that can best be obtained by training in more than one department of the University. A program leading to the degree of Doctor of Philosophy in Chemical Physics makes it possible for students to gain the necessary background and perform original research in this interdisciplinary field of science.

Applicants for admission should have undergraduate degrees in chemistry or physics, a grade average of at least 4.0, and a strong background in the major field of chemistry or physics, with more than the usual training in the other area. Those who received their degrees in physics should have the equivalent of one semester each of organic and inorganic chemistry and one year of physical chemistry. Those who received their degrees in chemistry should have the equivalent of one semester each of intermediate mechanics and intermediate electricity and magnetism. One year of mathematics beyond calculus is recommended. Deficiencies should be removed during the first year of study.

In addition to satisfying the usual requirements of the Graduate College, students must pass either the qualifying examination in the Department of Physics or the set of cumulative examinations given by the Division of Physical Chemistry. A knowledge of the content of Chemistry 348 and 349 or Physics 362 and 381 must be demonstrated also (for example, by passing the final examinations in these courses).

The program of graduate study consists of a suitable set of courses in the areas of mathematics, physics, and chemistry. A one-year course in quantum mechanics must be included, and the other courses must be selected from the three areas with the approval of the Committee on Chemical Physics.

Research for the dissertation is performed on appropriate problems under the direction of staff members who are currently active in chemical physics. Students may apply for fellowships and assistantships and may make use of the facilities available in the Chemistry and Physics Departments.

Inquiries concerning the program may be made to the Department of Chemistry and Chemical Engineering or the Department of Physics. Students with undergraduate degrees in chemistry should apply to the head of the Department of Chemistry and Chemical Engineering; students with undergraduate degrees in physics should apply to the head of the Department of Physics.

CHEMISTRY AND CHEMICAL ENGINEERING

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering. Attention is also called to a joint program leading to the degree Doctor of Philosophy in Chemical Physics (see above) and to the program in Biophysical Chemistry (see page 83).

Students who have fulfilled the undergraduate course requirements as specified below may apply for entrance to the Graduate College in chemistry or chemical engineering if they have a grade-point average of 4.0.

Students who have completed graduate work in chemistry or chemical engineering and related subjects at another institution may be admitted, provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0. Students whose undergraduate records have not met the above requirements must have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution in order to be admitted to the Graduate College in chemistry or chemical engineering.

All students who receive permits to enter the Graduate College in chemistry or chemical engineering, regardless of whether they have had training beyond the bachelor's degree, must take registration examinations. These are offered in the week prior to the opening of the first semester for those entering in the fall, and in the week prior to the opening of the second semester for those entering in February. Those who intend to major in any field of chemistry must take four examinations covering the normal undergraduate instruction in inorganic, analytical, organic, and physical chemistry. Those who intend to specialize in chemical engineering must take two of the examinations in chemistry, one of which must be physical chemistry and the other of the student's own selection; and, in addition, two in chemical engineering covering the usual undergraduate instruction in that subject. The results of these registration examinations are not permanently recorded but serve merely to assist in the registration of students in the proper graduate courses. Students with deficient preparation are required to register in one or more specific courses before taking more advanced work in a particular field. Most of these courses allow graduate residence credit. Students who have received permits to enter the Graduate College in chemistry or chemical engineering should contact the department immediately to learn the dates when these registration examinations are given and to obtain any other detailed information desired.

Students who are candidates for admission to the Graduate College in chemistry or chemical engineering must have had the equivalent of twenty-five semester hours in chemistry properly distributed.

Students who intend to take graduate work for an advanced degree in chemistry or chemical engineering should include in their undergraduate preparation at least the equivalent of one full year of physics, one year of French, one year of German, and mathematics through differential and integral calculus. Any student without the necessary language, physics, or mathematics may enter the Graduate College but is required to spend part of his time in residence to remove the deficiency.

Before taking chemistry or chemical engineering courses for graduate credit, graduate students whose major subject is in some department other than chemistry and chemical engineering must have had the equivalent of fifteen semester hours in chemistry, including satisfactory work in general chemistry, qualitative and quantitative analysis, and elementary organic chemistry. Such students are advised to make selections from the following courses: Chemistry 315, 316, 325, 327, 336, 337, 342, 343, 344, 345, 350, and 355. Courses of a more special nature are not, as a rule, accepted for graduate work unless preceded by one or more of the above courses.

A student majoring in another department who desires a sole minor in chemistry or chemical engineering toward the Doctor of Philosophy degree must include in his program Chemistry 342 and Chemistry 344, or must receive from the physical chemistry division of the department a statement that similar courses taken at other institutions are their equivalent. For fulfillment of the requirements for the sole minor the student must offer a minimum of four units, including credit earned in Chemistry 342 and 344, of which at least two, but usually three, units shall be in a single division of the department.

A student majoring in another department who desires a first minor in a division of the Department of Chemistry and Chemical Engineering toward the Doctor of Philosophy degree must include in his program Chemistry 342 and 343, or must obtain from the head of the physical chemistry division a written statement that similar courses taken at other institutions are their equivalent; in exceptional cases the head of the department may permit the substitution of Chemistry 340 and 341. For fulfillment of such a minor the student shall offer a

minimum of one and one-half units of additional course work in a single division of the department. A student who elects a first minor in one division and a second minor in another division of the department must meet all the requirements set forth for the sole minor in chemistry.

Candidates for the degree of Master of Science in the Teaching of Chemistry must meet the requirements set forth in connection with the Master of Science in the Teaching of the Physical Sciences (page 243).

CHEMICAL ENGINEERING

Candidates for advanced degrees in chemical engineering should have had undergraduate training comparable to that offered in the undergraduate chemical engineering curriculum at the University of Illinois. Students who enter without the usual engineering courses are required to make up their deficiencies to the extent prescribed by their adviser. Candidates for the Master of Science degree must include two chemical engineering courses of the 400 sequence in their programs.

BIOPHYSICAL CHEMISTRY

By addition of new staff and facilities the Department of Chemistry and Chemical Engineering, in collaboration with the Department of Microbiology, offers an area of specialization in biophysical chemistry. The program is flexible and provides the student with basic training in physical biochemistry and biology. Students electing this area should have a solid background in physics and mathematics. Details of the curriculum are decided individually on the basis of the past experience and interest of the student. It is expected, however, that the student fulfill minor requirements in microbiology or some other biological science.

Courses in the Department of Chemistry and Chemical Engineering especially related to this curriculum are Chemistry 346, 452, and 494 (same as Microbiology 494). Related courses also are offered in the Department of Microbiology (Microbiology 330, 405) and in the Biophysical Division of the Physiology Department (Biophysics 301, 401, 402, and 403).

The major research areas are (1) nucleic acids and proteins, their physical and chemical characterization and biosynthesis; (2) protein structure and activity; (3) physical chemistry of macromolecules in solution; (4) X-ray analysis of macromolecular structure; (5) chemistry of bioluminescence.

GRADUATE TEACHING FACULTY

Professors: H. E. Carter (Head of Department), L. F. Audrieth, J. C. Bailar, Jr., D. Y. Curtin, H. G. Drickamer, R. C. Fuson, I. C. Gunsalus, H. S. Gutowsky, H. F. Johnstone, H. A. Laitinen, N. J. Leonard, C. S. Marvel, T. Moeller, M. S. Peters, T. E. Phipps, H. R. Snyder, S. Swann, Jr., C. S. Vestling, F. T. Wall, J. W. Westwater, P. E. Yankwich.

Associate Professors: Virginia Bartow, T. J. Hanratty, H. V. Malmstadt, R. F. Nystrom.

Assistant Professors: D. E. Applequist, R. L. Belford, J. Berkowitz, T. L. Brown, R. Dickerson, R. S. Drago, B. D. Hall, A. H. Hartley, J. W. Hastings, J. P. Hummel, R. S. Juvet, A. Kuppermann, J. C. Martin, D. Perlmutter, T. S. Piper, J. A. Quinn, K. L. Rinehart, W. J. Rutter, L. K. Steinrauf, K. E. Van Holde, F. Wold.

Instructors: R. B. Bates, J. M. Clark, Jr.

Chemistry

COURSES FOR GRADUATES

402. **Inorganic Chemistry.** The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. I or II; 1 unit. MOELLER.

404. **Advanced Inorganic Chemistry Laboratory.** Specialized laboratory techniques; more difficult inorganic syntheses. II; ¼ to ¾ unit. Prerequisite: Credit or registration in one of the lecture courses in inorganic chemistry in the 400 series. AUDRIETH, MOELLER.

405. **Inorganic Chemistry.** Seminar. Required of all graduate students whose major is inorganic chemistry. I, II; ¼ unit. MOELLER.

406. **Structures of Inorganic Compounds and Mechanisms of Inorganic Reactions.** Qualitative study of the atomic and molecular orbital description of bonding; applications of these concepts to explain the structure and behavior of inorganic compounds; general formulation of rate processes, description of experimental techniques, treatment of kinetic data, and the elucidation of inorganic reaction mechanisms. I, II; 1 unit. Prerequisite: Chemistry 315. DRAGO.

408. **The Chemistry of Complex Inorganic Compounds.** The nature of the coordinate bond; applications of complex compounds. I or II; 1 unit. Prerequisite: Chemistry 315. BAILAR, PIPER.

420. **Electronic Instruments in Chemical Analysis.** Discussion of the principles and characteristics of electronic circuits and instruments used for analysis and research in chemistry. Laboratory experimentation and familiarization with basic instrumental components and specific chemical instruments. II; ½ unit. Prerequisite: Chemistry 327, or Chemistry 421 and 422, or consent of instructor. MALMSTADT, PFLUGER.

421. **Spectrochemical Methods of Analysis.** Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. I; 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree. MALMSTADT.

422. **Electrical Methods of Chemical Analysis.** Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. II; 1 unit. Prerequisite: Chemistry 344 or equivalent. LAITINEN.

423. **Electron Microscopy.** Lectures, discussions, and demonstrations on electron optics, design and operation of electron microscopes; sectioning, replication, and shadow casting of specimens; applications in various sciences. Open to qualified graduate students in all departments. I; ¼ unit. Prerequisite: Graduate standing with some background in chemistry, physics, and mathematics.

424. **Quantitative Analysis.** Advanced principles, including chemical statistics, calculations, experimental methods, and applications. II; ½ unit. HARTLEY.

425. **Analytical Chemistry.** Seminar. Required of all graduate students whose major is analytical chemistry. I, II; ¼ unit. LAITINEN.

426. **Applied X-rays.** Lectures. I; ¾ unit. Prerequisite: Training in physics and physical chemistry.

427. **Applied X-rays: Crystallography.** Lectures. II; ¾ unit. Prerequisite: Training in physics and physical chemistry.

428. **Applied X-rays.** Laboratory. Training in operation of all types of X-ray apparatus with special emphasis on diffraction; experimental chemical iden-

tification and crystal structure analyses from powder and single crystal patterns. I, II; ¼ to 1 unit. Prerequisite: Credit or registration in Chemistry 426 or 427.

429. **Electron Microscopy Laboratory.** Essentially individual instruction. Detailed training in operation and care of electron microscopes (four types); preparation of specimens including microtomy, electron staining, replication, and shadow casting; measurements and interpretations; special projects related to student's research interests. I, II; ¼ to ½ unit. Prerequisite: Graduate standing with some background in chemistry, physics, and mathematics; credit or registration in Chemistry 423; consent of instructor.

430. **Organic Chemistry.** Survey of organic chemistry designed for first-year graduate students. I, II; 1 unit. Prerequisite: One year (ten hours) of organic chemistry. CURTIN, FUSON.

432. **Organic Chemistry.** Advanced survey of organic chemistry. To follow Chemistry 430. II; 1 unit. Prerequisite: Chemistry 430 or equivalent. RINEHART.

433. **Organic Chemistry.** Molecular structure and reaction mechanisms with emphasis on stereochemistry. I; ¾ unit. Prerequisite: Chemistry 430 and 432, or consent of instructor. APPLEQUIST.

434. **Advanced Organic Synthesis.** I, II; ½ to 1 unit. BATES, LEONARD.

435. **Organic Chemistry.** Seminar. Current literature in organic chemistry. I, II; ½ unit. Prerequisite: Consent of instructor. In most cases, students must be doing research in organic chemistry and be registered for the degree of Doctor of Philosophy. MARTIN.

436. **Organic Chemistry.** Quantitative organic analysis and newer methods in organic laboratory procedure. A laboratory course designed to acquaint students with newer research techniques. I, II; ½ to 1 unit.

440. **Physical Chemistry.** Survey of physical chemistry for graduate students. I; 1 unit. Prerequisite: Consent of instructor.

441. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and their molecular interpretation; determination and chemical use of thermodynamic quantities. I; 1 unit. Prerequisite: Chemistry 342 and 344, or equivalent. BELFORD, GUTOWSKY.

442. **Statistical Thermodynamics.** Basic principles of classical and quantum statistics with applications to chemistry. II; 1 unit. Prerequisite: Chemistry 441 and 446, or consent of instructor. KUPPERMANN.

445. **Physical Chemistry.** Seminar. Required of all graduate students whose major is physical chemistry. I, II; ¼ to ½ unit. Prerequisite: Consent of instructor. GUTOWSKY.

446. **Quantum Chemistry, I.** An introduction to quantum mechanics: basic theory and methods of approximations; applications to atomic systems. II; 1 unit. Prerequisite: Chemistry 349 and Mathematics 388, or equivalent; consent of instructor.

447. **Quantum Chemistry, II.** Continuation of Chemistry 446. Application of quantum mechanics to chemical problems; theories of the chemical bond; structure and spectra of molecules. I; 1 unit. Prerequisite: Chemistry 446 or equivalent; consent of instructor.

448. **Chemical Kinetics.** Chemical reaction and the theory of rate processes. Lectures. I or II; ¾ unit. Offered in 1960-1961, I, and 1961-1962, II. Prerequisite: Chemistry 441; consent of instructor. KUPPERMANN, YANKWICH.

449. **Special Topics in Physical Chemistry.** An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as

molecular spectroscopy, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. Students may register for credit more than once. I, II; ½ to 1 unit. Prerequisite: Consent of instructor.

450. **Chemistry of Biological Processes.** A consideration at the molecular level of biological processes including bioenergetics, biosynthetic and degradative pathways of cellular components, metabolic regulation and enzyme reaction mechanisms. II; 1 unit. Prerequisite: Chemistry 350 and 355, or equivalent. GUNSALUS.

452. **Experimental Techniques in Biochemistry.** Experiments on the isolation, purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. I, II; ½ to 1 unit. Prerequisite: Chemistry 350 and 355. HALL, VESTLING, WOLD.

455. **Biochemistry.** Seminar. Discussions of current research and literature. Required of all graduate students whose major is biochemistry. I, II; ½ unit. Prerequisite: Chemistry 350 and 355, or equivalent. GUNSALUS.

492. **Chemical Literature and Reference Work.** I; ¼ unit. BARTOW.

494. **Chemical Basis of Biological Specificity.** Same as Microbiology 494. Biological formation and interaction of large molecules; an analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles. Nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; and metabolic interrelations of these molecules. I; ¾ unit. Prerequisite: Chemistry 344, 350 and 346, or 450; Microbiology 330; or consent of instructor.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Animal Nutrition 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. II; 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor.

499. **Thesis Research.** A candidate for the master's degree who elects research is required to present a thesis. A thesis is always required of students working toward the degree of Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in a department other than chemistry must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. I, II; 0 to 4 units. Work may be taken in the following fields, subject to the approval of one of the qualified staff members:

Analytical Chemistry. HARTLEY, JUVET, LAITINEN, MALMSTADT, PFLUGER.

Biochemistry. CARTER, GUNSALUS, HALL, HASTINGS, RUTTER, VESTLING, WOLD.

Biophysical Chemistry. DICKERSON, HALL, HASTINGS, STEINRAUF, VAN HOLDE, VESTLING, WOLD.

Inorganic Chemistry. AUDRIETH, BAILAR, BROWN, DRAGO, MOELLER, PIPER.

Organic Chemistry. APPLEQUIST, CURTIN, FUSON, LEONARD, MARTIN, MARVEL, RINEHART, SNYDER.

Physical Chemistry. BELFORD, DICKERSON, DRICKAMER, GUTOWSKY, HALL, HUMMEL, KUPPERMANN, PHIPPS, STEINRAUF, VAN HOLDE, WALL, YANKWICH.

Chemistry:

Applied Electrochemistry — Organic and Inorganic. SWANN.

Radiocarbon Chemistry. NYSTROM.

Research for the Ph.D. is also offered in specialized fields other than those illustrated above. Students who intend to major in chemistry in one of these special fields should consult with the professor in charge of the thesis and with the head of the Department of Chemistry and Chemical Engineering in regard to the programs of courses and examinations.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Inorganic Chemistry.** Nuclear and extranuclear atomic structures and their relation to the properties of the elements and of their compounds; types of bonding; survey of the periodic relationships; preparation, and applications of the elements and their compounds. I, II; ¾ unit. Prerequisite: Fifteen hours of credit in chemistry courses exclusive of courses numbered below 110. BROWN.

316. **Inorganic Chemistry.** Preparation of typical inorganic compounds illustrating special and more advanced techniques. I, II; ½ unit. Prerequisite: Credit or registration in Chemistry 315. BROWN, DRAGO.

324. **Introductory Microanalysis and Microscopy.** Qualitative spot tests, crystal tests, microscopic techniques; quantitative microvolumetric and gravimetric methods. Lectures and laboratory. I; ¾ unit. Prerequisite: Chemistry 124 or equivalent. HARTLEY.

325. **Analytical Chemistry.** A survey course for advanced undergraduate and graduate students requiring further training and review in analytical chemistry. I; ¾ unit. Prerequisite: Advanced standing in chemistry. LAITINEN.

327. **Special and Instrumental Methods of Analysis.** Electrical and optical methods, and other advanced analyses. I, II; ¾ unit. Prerequisite: Chemistry 124, 234, 342, and 343; or consent of instructor. HARTLEY, JUVET, MALMSTADT.

328. **Organic Functional Group Analysis.** A study of the quantitative separation and determination of organic compounds via functional groups: instrumental, manometric, gravimetric, and volumetric methods. II; ¾ unit. Prerequisite: Chemistry 124 and 336 or equivalent. JUVET.

333. **Applied Electrochemistry.** Use of electric current through solutions for carrying out reactions. Lectures. Open to students in the curriculum in chemistry and chemical engineering. II; ½ unit. Prerequisite: Chemistry 234, 336, and 344. SWANN.

336. **Organic Chemistry.** Second course. Lectures and recitations. I, II; ¾ unit. Prerequisite: Chemistry 124 and 234. FUSON, MARVEL.

337. **Organic Chemistry.** Laboratory experiments in organic chemistry. I, II; ½ unit. Prerequisite: Chemistry 234; credit or registration in Chemistry 336. APPLEQUIST, MARTIN.

338. **Systematic Identification of Organic Compounds.** I, II; ¾ unit. Prerequisite: Chemistry 336 and 337, or equivalent. LEONARD, RINEHART.

339. **Theoretical Organic Chemistry.** Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free radicals, and carbanions. II; ¾ unit. Prerequisite: Chemistry 338 or consent of instructor. APPLEQUIST.

340. **Elementary Physical Chemistry.** A one-semester course in chemical principles with emphasis on topics and applications most important to students in

agriculture, the biological sciences, and pre-medicine, and to graduate students needing a brief foundation course. Not open to students in the specialized curricula in chemistry or chemical engineering. I or II; ¾ unit. Prerequisite: Physics 102 or 104, Chemistry 122 and 133, or equivalent; registration in Chemistry 341. STEINRAUF, VAN HOLDE.

341. **Elementary Physical Chemistry Laboratory.** To accompany Chemistry 340. Quantitative experiments chosen to emphasize basic principles and also to acquaint the students with important laboratory techniques. I or II; ¼ unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry. STEINRAUF, VAN HOLDE.

342. **Physical Chemistry.** This course and Chemistry 344 constitute a one-year study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. I, II; ¾ unit. Prerequisite: Chemistry 124; Physics 106, 107, and 108, or two semesters of general physics with registration in the third semester; credit or registration in Mathematics 142 (preferred) or 147; or equivalents. BELFORD, DICKERSON, YANKWICH.

343. **Physical Chemistry Laboratory.** Quantitative experimental study of chemical principles. Chemistry 343 and 345 constitute a one-year introduction to experimental physical chemistry. They may be taken consecutively or concurrently. I, II; ¼ unit. Prerequisite: Chemistry 342. BELFORD, DICKERSON, STEINRAUF.

344. **Physical Chemistry.** Continuation of Chemistry 342. I, II; ¾ unit. Prerequisite: Chemistry 342. BELFORD, DICKERSON, YANKWICH.

345. **Physical Chemistry Laboratory.** Continuation of Chemistry 343. May be taken concurrently with Chemistry 343. I, II; ¼ unit. Prerequisite: Chemistry 342; credit or registration in Chemistry 343 and 344. BELFORD, DICKERSON, STEINRAUF.

346. **Physical Chemistry of Macromolecules.** The physical properties of systems containing large molecules, with special emphasis on proteins and high polymers; the use of physical methods for the characterization of such substances. I or II; ¾ or 1 unit (laboratory required for 1 unit). Prerequisite: Chemistry 344. HALL, VAN HOLDE.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. Graduate students registering for one unit do a special project. I; ¾ or 1 unit. Prerequisite: Chemistry 344 or equivalent.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. Graduate students registering for one unit do a special project. II; ¾ or 1 unit. Prerequisite: Chemistry 348. KUPPERMANN.

350. **General Biochemistry.** The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings. I, II; ¾ unit. Prerequisite: Chemistry 122 or 124, and 133 or 234, or equivalent; registration in Chemistry 355. CARTER, VESTLING.

51. **Metabolic Processes, Problems and Methods.** Laboratory experiments stress methods of conducting metabolic experiments with tissues, cells, cell components, and enzymes. Weekly discussions consider present concepts of the mechanism of chemical transport, hormone control, energy release, and of biosynthesis. II; ¾ unit. Prerequisite: Chemistry 350 and 355. HASTINGS.

54. **Introduction to Biochemistry.** Lectures: Structure and function of living matter, with emphasis on the mammalian organism. Laboratory: The isolation, chemical characterization, and function of the structural and catalytic components of living cells. This course is designed primarily to meet the needs of veterinary medicine, nutrition, dietetics, and other professional students. Open to other students only by special permission when space is available. This course does not meet the requirements for registration in advanced courses in biochemistry. I; 1 unit. Prerequisite: Chemistry 122 or 124 and 133 or 234, or equivalent; laboratory course in general biology, botany, or zoology; or consent of instructor. HASTINGS, VESTLING.

55. **Biochemistry Laboratory.** An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance; identification and quantitative measurement of constituents and transformations in biological systems. Laboratory, quizzes, and readings. To accompany Chemistry 350. Required of all students who expect to take advanced courses in biochemistry. I, II; ¾ unit. Prerequisite: Chemistry 122 or 124; Chemistry 133 or 234, or equivalent; registration in Chemistry 350. CLARK, NEUHAUS, RUTTER.

391. **Special Problems in High School Chemistry.** Designed to strengthen the chemical background of high school teachers and to integrate teaching of high school and college chemistry courses. Lectures, conferences, problems, and reports. Adapted to individual needs. I, II; ½ to 1 unit. Prerequisite: Experience in high school chemistry teaching.

393. **The Status of Modern Chemistry.** Lectures, demonstrations, discussions, and literature assignments in specialized areas of chemistry and chemical engineering, including analytical, inorganic, organic, and physical chemistry, biochemistry, and chemical engineering. Designed to broaden and strengthen the base of experience and knowledge of high school teachers. S; ¾ to 1 unit. Prerequisite: College degree; high school chemistry teacher status. MOELLER.

395. **History of Science with Particular Reference to Chemistry.** I; ½ unit. Prerequisite: Twenty hours of laboratory science. BARTOW.

396. **Atomic Physics.** Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics include the atomic nature of matter, the properties of free electrons, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, an introduction to the ideas of quantum mechanics, binding in molecules and crystals, and in an introduction to some solid state phenomena. It is recommended that chemistry majors take Chemistry 344 before registering in this course. I, II; 1 unit. Prerequisite: General physics and calculus.

397. **Radiochemistry.** Same as Nuclear Engineering 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, and interactions of radiations with matter. Lectures. I, II; ½ unit. Prerequisite: One semester of physical chemistry or consent of instructor. HUMMEL.

398. **Radiochemistry Laboratory.** Same as Nuclear Engineering 398. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. Laboratory and discussions. I, II; ½ unit. Prerequisite: One semester of physical chemistry or consent of instructor. HUMMEL.

Chemical Engineering

COURSES FOR GRADUATES

464. **Diffusional Operations.** The principles of countercurrent and stagewise mass transfer and their application to practical problems of separation. Lectures. I; 1 unit. Prerequisite: Chemical Engineering 373. DRICKAMER, PETERS.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. I, II; ¼ unit. Prerequisite: Chemical Engineering 373. DRICKAMER, PETERS.

466. **Applied Mathematics in Chemical Engineering.** Setting up and solving the boundary value problems which frequently occur in chemical engineering. II; ¾ to 1 unit. Prerequisite: Mathematics 343, 345 or equivalent, or consent of instructor. HANRATTY, QUINN.

467. **Distillation.** Application of principles of distillation to binary and multicomponent mixtures including a discussion of azeotropic and extractive distillation. II; ¾ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Chemical Engineering 373. DRICKAMER.

468. **Applied Reaction Kinetics for Chemical Engineers.** Chemical engineering kinetics as used in the design of plants. Lectures. II; ¾ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Chemical Engineering 373; consent of instructor. PETERS.

469. **Special Topics in Chemical Engineering.** The prediction of physical properties from the molecular theories of matter. I or II; ¾ to 1 unit. Offered in 1959-1960 and in alternate years. Prerequisite: Mathematics 343 and 345, or consent of instructor. DRICKAMER.

487. **Flow of Fluids.** Advanced course. Lectures, recitations, and problems. II; ¾ unit. Prerequisite: Chemical Engineering 371, or equivalent with consent of instructor. HANRATTY.

488. **Heat Transmission.** Advanced course. Lectures, recitations, and problems. I; ¾ unit. Prerequisite: Chemical Engineering 371, or equivalent with consent of instructor. WESTWATER.

499. **Thesis Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the degree of Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another department must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. I, II; 0 to 4 units. DRICKAMER, HANRATTY, JOHNSTONE, PETERS, SWANN, WESTWATER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Process Engineering.** Same as Food Technology 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food technology; not open to majors in chemical engineering. Lectures and problems. I; ¾ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Chemistry 340 or 342 or consent of instructor; one year of calculus. QUINN.

368. **Chemical Engineering Kinetics.** Principles of reaction kinetics and applications to reactor design. II; ¾ unit. Prerequisite: Chemical Engineering 370. PETERS.

370. **Chemical Engineering Thermodynamics.** The fundamental concepts and

laws of thermodynamics. Primarily for students in chemical engineering. II; ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 342. QUINN.

71. **Principles of Chemical Engineering.** Introduction to fluid dynamics and heat transfer. Lectures, problems, and quizzes. I, II; 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor. HANRATTY, QUINN.

73. **Principles of Chemical Engineering.** Introduction to mass transfer operations. Lectures, problems, and quizzes. I, II; 1 unit. Prerequisite: Chemical Engineering 371. PERLMUTTER, WESTWATER.

74. **Unit Operations Laboratory.** To accompany Chemical Engineering 373. Laboratory and computations in the unit operation. I, II; ½ unit. Prerequisite: Credit or registration in Chemical Engineering 373. HANRATTY, PERLMUTTER.

77. **Process Dynamics.** The basic ideas of process dynamics and their applications in chemical engineering. II; ¾ unit. Prerequisite: Chemical Engineering 267; Mathematics 343 or 345; or consent of instructor. PERLMUTTER.

79. **Chemical Engineering Projects.** Laboratory. Development of an individual project. I, II; ½ unit. PERLMUTTER, WESTWATER.

80. **Heat, Mass, and Momentum Transport.** A unifying treatment of physical rate processes with particular emphasis on the formulation and solution of typical boundary value problems associated with heat, mass, and momentum transport. I; ¾ unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 371; or consent of instructor. HANRATTY, QUINN.

81. **Chemical Engineering Plant Design.** Comprehensive problems, lectures, and discussion on plant design and the economic factors involved in design and operation of chemical plants. I, II; ½ unit. Prerequisite: Chemical Engineering 373. PERLMUTTER, PETERS.

82. **The Prediction of Physical Properties.** The prediction of equilibruim and transport properties in gases, liquids, and solids. II; ½ unit. Prerequisite: One year of physical chemistry. DRICKAMER.

CITY PLANNING AND LANDSCAPE ARCHITECTURE

The Department of City Planning and Landscape Architecture offers graduate work leading to the Master of Fine Arts and Master of Science degrees. Students applying for admission must have a grade-point average of at least 3.5.

Degree of Master of Science in City Planning. College graduates in liberal arts and sciences as well as architecture, city planning, civil engineering, and landscape architecture are offered an opportunity to prepare themselves for careers in city, state, and regional planning. After completing their preparation they are qualified for positions with city, metropolitan, state, and regional planning commissions.

The prerequisite for graduate work in city planning is a bachelor's degree and must include courses of the following character or their equivalents: city planning (introductory), three hours; sociology (urban, rural, or regional), three hours; political science (municipal government; public administration), three hours; economics (urban land economics; public finance), three hours; geography (urban or rural), three hours; design (skill in graphic expression; landscape, architectural, or highway and municipal design; regional design), twelve hours.

To qualify for this degree a student must take the seminar and thesis courses for three units and at least five additional units chosen from the following fields: architecture, city planning, civil engineering, economics, geography, political science, sociology.

Degree of Master of Fine Arts in Landscape Architecture. The prerequisite for graduate work in landscape architecture is a bachelor's degree in landscape architecture substantially equivalent to the degree conferred by the University of Illinois.

To qualify for this degree a student must take the seminar and thesis courses for three units and at least five additional units chosen from the following: architecture, botany, city planning, civil engineering, landscape architecture.

GRADUATE TEACHING FACULTY

Professors: L. B. Wetmore (Head of Department), B. Hackett.
Associate Professors: W. I. Goodman, W. M. Keith, S. Keyes, P. H. Lewis.
Assistant Professor: R. Katz.

City Planning

COURSES FOR GRADUATES

437. **Advanced City Planning Design.** Analysis and synthesis of problems and possibilities in the layout of average towns and cities and their surroundings. I, II; 1 to 2 units. Prerequisite: City Planning 337 and 338, or consent of instructor.

487. **Seminar.** I, II; ½ unit.

488. **City Planning Research.** Individual and group instruction in application of professional training in city planning and other fields to the analysis of urban planning problems and to the development of approaches to solution of these problems. I, II; ½ to 2 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** I, II; ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **City Planning Design.** I; 1 unit. Prerequisite: Landscape Architecture 236 or consent of instructor.

338. **City Planning Design.** II; 1 unit. Prerequisite: City Planning 337 or consent of instructor.

372. **Theory and Practice.** The unified development of communities; comprehensive arrangement of land uses and land occupancy. I, II; ½ unit.

376. **Planning Procedures, Methodologies, and Practice.** Procedures involved in major types of planning services, special planning studies, planning techniques and methodologies, organization and administration of planning staffs and agencies, professional practice. I; ½ unit. Prerequisite: Consent of instructor.

378. **Planning Administration and Legislation.** Legal tools of planning, zoning, subdivision regulations, housing codes, methodology and application; administrative procedures of planning; the place of planning in the structure of government; the capital improvement program. II; ½ unit. Prerequisite: Political Science 150 or 151, 305 or 306, or consent of instructor.

Landscape Architecture

COURSES FOR GRADUATES

436. **Advanced Landscape Design.** Landscape design of large private, semipublic, and public properties. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

47. **Advanced Landscape Construction.** Construction problems connected with large private and public landscape developments. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

57. **Advanced Planting Design.** Theory and application of planting design in relation to private, semi-public, and public properties. I, II; 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

87. **Seminar.** I, II; ½ unit.

99. **Thesis Research.** I, II; ½ to 2 units. STAFF.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The Department of Civil Engineering offers advanced study and professional raining in the general fields of highway engineering, hydraulic engineering, railway ngineering, sanitary engineering, soil mechanics and foundation engineering, structural engineering, geodetic and photogrammetric engineering, and traffic engineering. Facilities for research are available in all these fields, and active research programs directed by members of the staff are under way. In programs of graduate tudy emphasis is placed on both course work and research.

The degrees of Master of Science and Doctor of Philosophy may be attained by qualified students who satisfy the requirements of the department and the Graduate College. Progress toward an advanced degree is measured not only by he accumulation of units of credit in formal course work but also by evidence of intellectual growth and achievement. A prerequisite for graduate work in civil engineering is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired.

The work in sanitary engineering leads to the degree of Master of Science in Sanitary Engineering and to the degree of Doctor of Philosophy in Sanitary Engineering. The prerequisite for admission to the first year of graduate study is a degree of Bachelor of Science in Engineering, including basic courses in bacteriology, quantitative chemical analysis, and organic chemistry, or their equivalent in the fields of chemistry and biology.

Admission to the Graduate College with full status in civil or sanitary engineering is granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois, provided the applicant's preparation is appropriate to advanced study in his chosen major field and his scholastic average is at least 4.0. Under certain conditions, applicants with a grade-point average of less than 4.0, and applicants from schools with different grading systems, may be considered if their average is at least the equivalent of 3.75 and evidence is submitted indicating that the applicant's ability is not appropriately measured by the grades submitted.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or a minor are subject to the review of, and must be approved by, the head of the department.

A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units are required.

A pamphlet entitled "Graduate Study and Research in Civil and Sanitary Engineering," describing the opportunities for graduate work and research in the Department of Civil Engineering, is available upon request to the head of the department, 205 Civil Engineering Hall, Urbana, Illinois.

GRADUATE TEACHING FACULTY

Professors: N. M. Newmark (Head of Department), W. C. Ackermann, E. E. Bauer, J. W. Briscoe, V. T. Chow, E. Danner, D. U. Deere, G. H. Dell, R. Engelbrecht, E. H. Gaylord, R. E. Grim, W. J. Hall, J. D. Haltiwanger, W. W. Hay, H. O. Ireland, W. H. Munse, W. A. Oliver, R. B. Peck, M. O. Schmidt, C. P. Siess, T. H. Thornburn, A. S. Veletsos.

Associate Professors: W. J. Austin, J. E. Baerwald, B. B. Ewing, J. C. Guillou, M. Herrin, E. Y. Huang, N. Khachaturian, V. J. McDonald, R. J. Mosborg, G. K. Sinnamon, M. A. Sozen, J. E. Stallmeyer.

Assistant Professors: J. G. Hammer, H. M. Karara.

Instructor: R. E. Olson.

Lecturer: K. Terzaghi.

COURSES FOR GRADUATES

401. **Geodetic Engineering.** Elements of geodesy; principles and practice of precise triangulation, traverse, and levels. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. Schmidt.

402. **Geodetic Engineering.** Precise astronomic determination of time, latitude, longitude, and azimuth. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. Schmidt.

403. **Photogrammetry.** Study of the principles of stereoscopy and geometrical optics; aerial cameras, their design and calibration; the design, construction, and operation of stereoscopic plotting machines; mathematics of stereoscopic orientation and model deformations. I; 1 unit. Prerequisite: Civil Engineering 302, or consent of instructor. Karara.

404. **Photogrammetry.** Theory of errors of stereoscopic photogrammetry; aerotriangulation (spatial and radial), its theory and applications to various civil engineering problems; electronics in photogrammetry; practice in compiling maps from aeriel and terrestrial photographs. II; 1 unit. Prerequisite: Civil Engineering 302, or consent of instructor. Karara.

420. **Pavement Design, I.** Analysis and methods of measurement of surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper surface properties, load carrying capacity, wear resistance, stability and durability. I; 1 unit. Prerequisite: Civil Engineering 220 or equivalent. Danner.

421. **Pavement Design, II.** Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. II; 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor. Danner.

426. **Traffic Planning.** Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. I; 1 unit. Prerequisite: Civil Engineering 325 or equivalent. Baerwald.

427. **Geometric Highway Design.** Highway classification; highway capacity; highway design controls; sight distance; horizontal and vertical alignment; cross section elements; highway types; controlled access highways; design of at-grade intersections, grade separations, and interchanges. II; 1 unit. Prerequisite: Civil Engineering 325 and 426, or consent of instructor. Baerwald.

428. **Traffic Engineering Operations.** Theory of traffic control; laws and ordi-

ances; design and application of traffic control devices; special street designations; parking design and control; street illumination; miscellaneous traffic control designs. II; 1 unit. Prerequisite: Civil Engineering 325 and 426, or equivalent. BAERWALD.

35. **Railway Construction and Maintenance.** Roadbed load capacity; economic design of track; advanced geometric design; economics of maintenance; grade crossing separations; review of specific projects. I; 1 unit. Prerequisite: Civil Engineering 335. HAY.

36. **Railroad Location and Operation.** Traffic and traffic capacity; optimum train size, performance, and scheduling; validity and accuracy of current practices; regional operating factor; optimum size of plant and modern location. II; 1 unit. Prerequisite: Civil Engineering 336. HAY.

40. **Theory of Water Treatment.** Properties of water and criteria of water quality; gas transfer operations in water treatment; chemical treatment processes; corrosion and corrosion control; sedimentation; filtration; disinfection; control of aquatic growths; and control of tastes and odors. I; 1 unit. Prerequisite: Chemistry 122; Microbiology 101. ENGELBRECHT, EWING.

41. **Water Purification Laboratory and Design.** An extension of principles and application to experimental determination of design and operational criteria for various physical, chemical, and biological unit operations used in water purification processes. I; 1 unit. Prerequisite: Credit or registration in Civil Engineering 440 or consent of instructor. EWING.

42. **Theory of Waste-Water Treatment.** Composition, properties, and analysis of wastes; microbiology of waste treatment; pollution of natural waters; sedimentation; chemical treatment; aerobic and anaerobic treatment processes; disposal of waste sludges. II; 1 unit. Prerequisite: Chemistry 122; Microbiology 101. ENGELBRECHT.

43. **Waste Treatment Laboratory and Design.** An extension and application to experimental determination of design and operational criteria for various physical, chemical, and biological unit operations used in waste treatment processes. II; 1 unit. Prerequisite: Credit or registration in Civil Engineering 442. ENGELBRECHT.

44. **Industrial Wastes.** Advanced considerations of industrial wastes problems of major waste-producing industries including the process producing the waste, waste composition, treatment methods, and inplant abatement techniques. II; ½ to 1 unit. Prerequisite: Civil Engineering 442 and 443 or consent of instructor.

45. **Fundamentals of Biological Treatment.** A detailed consideration of basic biological and chemical phenomena applied to aerobic and anaerobic treatment of aqueous wastes. I; 1 unit. Prerequisite: Credit or registration in Civil Engineering 443 or consent of instructor. ENGELBRECHT, GAUDY.

46. **Design of Water and Waste Treatment Plants.** A study of the fundamental factors affecting choice of treatment units and combination of unit processes into an integrated plant. II; 1 unit. Prerequisite: Civil Engineering 440, credit or registration in Civil Engineering 442, or consent of instructor. EWING.

47. **Radioactive Waste Disposal.** Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous waste disposal; air monitoring; and reactor site selection and hazards evaluation. II; ½ to 1 unit. Prerequisite: Physics 282 or Chemistry 398 (Nuclear Engineering 398) or consent of instructor. EWING.

450. **Advanced Hydrologic Analysis and Design.** Hydrologic cycle; hydrometeorology; collection of data; hyetograph and hydrograph analyses; infiltration and evapotranspiration studies; groundwater exploration and recharge; statistical analyses; determination of waterway areas; flood routings; river and reservoir regulations; design and planning of flood control projects; and modern development such as radar weather, radioactive tracers, disposal of nuclear wastes, and electronic analogs. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering, or consent of instructor. CHOW.

452. **Water Resources Planning and Development.** Purposes and techniques of planning water resources developments; evaluation of social and economic aspects of water conservation projects and development of an actual proposal. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. GUILLOU.

455. **Water Power Engineering.** Survey and evaluation of power resources; preliminary investigation of plant site; hydrologic analysis of power supply; study and selection of hydraulic turbomachinery; design of hydraulic structures, power plant and appurtenances, and control works; cavitation; water hammer analysis; governor design; power economics; design and analysis of hydro, steam, and nuclear power associations. II; 1 unit. Prerequisite: Consent of instructor. CHOW.

456. **Hydraulics of Surface Drainage.** Applications of hydraulics and hydrologic principles; elements of channel design, hydrologic determination of design flow, hydraulics of culverts and bridge openings, overland flow, flow in gutters and inlets, and hydrologic and hydraulic design of a bridge opening or culvert system. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234, or equivalent. GUILLOU.

458. **Open-Channel Hydraulics.** Basic hydromechanics; flow types; channel characteristics; flow-profile computations; hydraulic jump analysis; design of nonerodible, erodible, and grassed channels and transitional structures; study of supercritical flow and unsteady flow; modern developments in theory and design practice; application of numerical method, method of characteristics, method of singular point, and electronic digital computers and analogs. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering, or consent of instructor. CHOW.

460. **Structural Analysis.** Basic theory of indeterminate structures; deflections and displacements; continuous beams and frames; virtual work; qualitative and quantitative influence lines. I, II; ½ to 1 unit. Prerequisite: Bachelor of Science degree in engineering with a course in theory of simple structures. OLIVER.

461. **Structural Theory and Design.** Advanced structural theory from the standpoint of design, analysis, and behavior, with particular emphasis on analysis; evaluation of methods of elastic analysis of structures; limit design and analysis; continuous beams and frames; multiple-story structures; space frames; arches. I, II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering; Civil Engineering 361 or 460, or equivalent. HALL.

462. **Structural Theory and Design.** Statically indeterminate trusses; continuous trusses; steel arches; secondary stresses; suspension bridges; long-span roofs. I, II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering; Civil Engineering 361 or 460, or equivalent. MOSBORG.

464. **Reinforced Concrete Design.** Theories of action of beams, slabs, and columns of reinforced concrete; codes and specifications and their influence on design; effect of continuity. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with courses in structures. BRISCOE.

465. **Structural Design in Metals.** Theories of behavior of structural metal members and their components; interpretation of codes and specifications for the design of bridges and buildings. This course and Civil Engineering 475 supplement one another in the study of theoretical and experimental behavior of metal structures. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with courses in structures. GAYLORD.

467. **Behavior of Reinforced Concrete Structures.** Ultimate strength and behavior of statically indeterminate reinforced concrete structures; applicability of elastic analysis to framed structures; analysis and design of floor slabs in buildings. II; 1 unit. Prerequisite: Civil Engineering 366. SIESS.

468. **Analysis and Design of Prestressed Concrete Structures.** The principles of linear prestressing; the properties of materials used in prestressed concrete; service load and ultimate design of simply supported prestressed concrete beams; strength and behavior of prestressed concrete beams; composite sections; analysis, behavior and design of continuous prestressed concrete beams. I, II; 1 unit. Prerequisite: Bachelor of Science degree in civil or architectural engineering with courses in reinforced concrete and in analysis of indeterminate structures. KHACHATURIAN.

469. **Wood Structures.** Theory and practice in the design of modern wood structures; the effect of the plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. I, II; 1 unit. Prerequisite: Bachelor of Science degree in civil, architectural, or agricultural engineering, or consent of instructor. OLIVER.

471. **Numerical and Approximate Methods of Structural Analysis.** Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns, moments and deflections of beams resting on elastic or plastic supports, vibration of beams, analysis of arches, moments and deflections of plates, and other problems. I, II; 1 to 2 units. AUSTIN, HAMMER.

472. **Advanced Numerical Methods in Engineering.** Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, characteristic value problems, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures, blast, impact, and earthquake effects on structures, buckling and flexure of frameworks, torsion of solid and thin-walled sections, lateral buckling of beams, bending and buckling of plates and of stiffened plates, plane stress and axially symmetric problems in elasticity, and other topics. II; 1 to 2 units. Prerequisite: Civil Engineering 481. AUSTIN.

473. **Analysis and Design of Plates and Shells.** Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highway and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs, and hipped plate construction. I; 1 to 2 units. Prerequisite: Consent of instructor. VELETSOS.

474. **Behavior of Structures Under Dynamic Loads.** Free vibrations, forced vibration, and transient response of structures and structural components having one or many degrees of freedom; analytical methods for the effects of wind load, explosion blast, impact, earth tremors, and other time dependent excitations; effects of damping and inelastic action; propagation of stress

waves; wind induced vibrations with application to cables, pipelines, and tall stacks. II; 1 to 2 units. Prerequisite: Consent of instructor. VELETSOS.

475. **Behavior of Steel Structures.** A critical evaluation of the actual behavior of metals, connections, members, and structures; the significance of this behavior in terms of design and the development of design specifications. This course and Civil Engineering 465 supplement one another in the study of theoretical and experimental behavior of metal structures. I; 1 unit. Prerequisite: Graduate standing in civil engineering or theoretical and applied mechanics. MUNSE.

476. **Design of Lightweight Structures.** Fundamental theory of thin-walled structural members; applications to design of metal structures with emphasis on light-gage, cold-formed members; comparative studies of design specifications for metal structures. II; 1 unit. Prerequisite: Civil Engineering 465. GAYLORD.

477. **Design of Structures for Dynamic Loads.** Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast-resistant structures; criteria for design of earthquake resistant structures; application to actual problems. I; 1 unit. HALTIWANGER, NEWMARK.

480. **Earth Pressures and Retaining Structures.** Classical and modern pressure theories and their experimental justification; pressures and bases for design of retaining walls, bracing of open cuts, anchored bulkheads, cofferdams, tunnels and culverts. I; 1 unit. Prerequisite: Credit or registration in Civil Engineering 383, or consent of instructor. DEERE, PECK.

481. **Earth Dams and Related Problems.** Fundamentals of problems of slope stability; seepage in composite sections and anisotropic materials; methods of stability analysis; mechanism of failure of natural and artificial slopes; compaction; field observations. II; 1 unit. Prerequisite: Credit or registration in Civil Engineering 384, or consent of instructor. DEERE, PECK.

482. **Measurement of Soil Properties.** Laboratory and field work in soil sampling, classification, and testing; experimental studies of modern soil mechanics parameters and theories with emphasis on applications to design problems. Experiments include permeability, consolidation, direct shear, and triaxial shear. The research approach is used to point out interpretations and limitations of data in practice. I, II; 1 unit. Prerequisite: Credit or registration in Civil Engineering 383.

483. **Soil Mechanics.** Advanced studies of research techniques in soil mechanics and foundation engineering. I; 1 unit. Prerequisite: Civil Engineering 384 or consent of instructor. PECK.

484. **Foundation Engineering.** Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. II; 1 unit. Prerequisite: Credit or registration in Civil Engineering 384 or consent of instructor. DEERE, PECK.

485. **Soil Engineering for Transportation Facilities.** Problems of soil classification; evaluation of stability of natural and compacted soils as subgrades, slopes and embankments; effect of climate, soil properties, compaction, and admixtures on subgrade stability. II; 1 unit. Prerequisite: Civil Engineering 383 or equivalent. THORNBURN.

494. **Municipal Administration and Engineering.** Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city

planning and zoning; building codes and inspection; street lighting; public utilities; city cleaning; recreational development. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. DANNER.

495. **Highway and Traffic Seminar.** Current problems and research developments in highway transportation, administration, and engineering. (To be followed by Civil Engineering 496.) I; no credit. BAERWALD, DANNER.

496. **Highway and Traffic Seminar.** Continuation of Civil Engineering 495. Current problems and research developments in highway transportation, administration, and engineering. II; no credit. BAERWALD, DANNER.

497. **Special Problems.** Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who will supervise the investigation. I, II; 0 to 4 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Surveying.** Precise horizontal and vertical control surveys; state plane coordinate systems; and special construction surveys. II; ½ unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp), senior standing, or consent of instructor. SCHMIDT.

302. **Photogrammetric Engineering.** A study of metrical photography in civil engineering practice; characteristics and interpretation of aerial and terrestrial photographs; stereoscopic compilation of maps from photographs; mosaics; economics of photogrammetry; map reproduction. I, II; ½ unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp), senior standing, or consent of instructor. KARARA.

303. **Cadastral Engineering.** Original, retracement, and subdivisional surveys in relation to real property. I; ½ to 1 unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp), senior standing, or consent of instructor. ELDRIDGE, SCHMIDT.

304. **Survey Adjustments and Least Squares.** Theory of errors; method of least squares; measures of precision; the adjustment of triangulation, traverse and level nets; and special problems. II; ½ to 1 unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp), senior standing, or consent of instructor. KARARA.

315. **Fundamentals of Construction Engineering.** Fundamentals of construction analysis; factors affecting construction productivity; introduction to construction operations planning; summation of engineering fundamentals of structural analysis, material properties, and design requirements as they affect construction; introduction to construction management. I, II; ½ unit. Prerequisite: Senior standing in engineering or architecture, or consent of instructor.

316. **Construction Equipment Analysis.** An analysis of the factors which affect the operation of construction equipment. Cost of operation and productivity are the fundamental comparison units for the selection of construction equipment. I, II; ½ unit. Prerequisite: Civil Engineering 315.

318. **Construction Cost Analysis.** Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts and statistical measurements of the factors involved in direct costs, general overhead costs, cost mark-ups and profits; the fundamentals of cost recording for construction cost accounts and cost controls. I, II; ½ unit. Prerequisite: Senior standing in engineering or architecture, or consent of instructor.

321. **Bituminous Materials and Mix Design.** Properties and control testing of bituminous materials; analysis of bituminous paving mixtures; composition and design of asphaltic concrete and soil-asphalt mixes. I, II; ½ unit. Prerequisite: Civil Engineering 214 and 220, or consent of instructor. HERRIN.

322. **Development of Highway Facilities.** Analysis of factors in developing a highway transportation facility; traffic estimates and assignment; problems of highway geometrics and design standards; planning and location principles; intersection design factors; street systems and terminal facilities; programming improvements; drainage design; structural design of surface; concepts of highway management and finance; highway maintenance planning. I, II; 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

325. **Highway Traffic Characteristics.** Vehicle operating characteristics; driver characteristics; pedestrian characteristics; roadway characteristics as they individually, and collectively as traffic stream characteristics, are related to the planning, design, and operation of highway facilities. I, II; ½ unit. Prerequisite: Civil Engineering 220 or consent of instructor. BAERWALD.

333. **Urban and Regional Transportation.** Importance of transportation and its relation to urban and regional planning; characteristics of transport systems; transportation planning including surveys, data analysis, and problems of administration and finance; coordination and integration of transport. I; ½ to 1 unit. Prerequisite: Senior or graduate standing, or consent of instructor. HAY.

334. **Airport Design.** Basic principles of site selection for airports and fundamental considerations of design, construction, and maintenance of airport pavements and structures. II; ½ to 1 unit. Prerequisite: Civil Engineering 220 and senior standing in civil engineering, or consent of instructor. HERRIN.

335. **Railway Construction and Maintenance.** Loads and load distribution on track and subgrade; roadbed construction and stabilization; track stresses, design, and materials; turnouts and crossings; maintenance programs. I; ½ to 1 unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp) and senior standing, or consent of instructor. HAY.

336. **Railway Location and Operation.** Influence of traffic, alignment, distance, gradients, and active power upon operating expenses; mechanics of train operation; economic design of location. II; ½ to 1 unit. Prerequisite: Civil Engineering 207 (Summer Surveying Camp) and senior standing, or consent of instructor. HAY.

337. **Signals.** Train movements; systems of signals; tract circuits; track capacity; interlockings; economics of signaling. I; ½ to 1 unit. Prerequisite: Senior standing or consent of instructor. HAY.

338. **Terminals.** Design and operation of freight terminal facilities for rail, highway, air and water carriers; passenger terminals; special terminal requirements for specific commodity categories; coordination. II; ½ to 1 unit. Prerequisite: Senior standing or consent of instructor. HAY.

345. **Public Health Engineering.** The application of engineering principles to the control of environmental sanitation, including administration, biostatics, communicable disease control, epidemiology, industrial health and air contamination, housing, vector control, radiological health, refuse collection and disposal, milk and food sanitation, swimming pools, and individual water supply and waste water disposal. I; ½ unit. Prerequisite: Senior standing in engineering or consent of instructor. ENGELBRECHT.

348. **Air Pollution.** A study of the characteristics of air contaminants from industrial and domestic sources; their effect and methods of control; air pollution surveys; and organization of control programs. I; ½ unit. Prerequisite: General Engineering 360 or consent of instructor. ENGELBRECHT.

352. **Water Resources.** Importance of a water resources program to regional development; evaluation of water resources and a water resource plan, including constitutional and legislative concepts, as applied to an actual river basin; engineering evaluation of surface, subsurface, and drainage law. I; ¾ to 1 unit. Prerequisite: Credit or registration in Civil Engineering 250. Guillou.

353. **River Hydraulics.** Open channel flow; functions of rivers and streams; stream gaging and analysis; river hydrology; river mechanics; stream sanitation; river navigation; stream control structures. I; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232. Guillou.

354. **Hydraulic Structures, I.** Functions and types of dams; factors influencing selection of type; seepage, piping and stability investigations for earth dams; outlet works and spillways for low dams; loads, design criteria, and stress investigation procedures for concrete dams. I, II; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232; credit or registration in Civil Engineering 380. Chow.

355. **Hydraulic Structures, II.** Design of spillways and outlets for high dams, navigation locks and irrigation structures; selection of hydraulic machinery; design of surge tanks, penstocks, and hydroelectric powerhouses; analysis of hydrologic and power market data. II; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. Chow.

356. **Hydraulic Engineering Laboratory.** Fundamental principles; operation and use of model laboratories; dimensional analysis; hydraulic similitude; theory and design of hydraulic models as applied to a specific laboratory problem. II; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. Guillou.

361. **Advanced Structural Analysis.** Continuation of Civil Engineering 262. General theory of continuity; prismatic and nonprismatic members; column analogy; continuous framed structures; trussed structures; numerical methods of analysis. I, II; ½ unit. Prerequisite: Civil Engineering 262. Stallmeyer.

363. **Structural Design in Metals, II.** Continuation of Civil Engineering 263. Members under combined loads; riveted, bolted, and welded connections; simple and moment-resistant connections; ultimate strength and limit design. I; ½ unit. Prerequisite: Civil Engineering 263. Dell, Gaylord.

364. **Reinforced Concrete Design, II.** Continuation of Civil Engineering 264. Flexural and torsional deformations of reinforced concrete sections; analysis and design of frames; analysis and design of various types of slabs; elastic and inelastic behavior of reinforced concrete elements; time-dependent effects. I, II; ½ unit. Prerequisite: Civil Engineering 264; credit or registration in Civil Engineering 361. Khachaturian, Siess.

366. **Behavior of Reinforced Concrete Members.** Ultimate strength and behavior of reinforced concrete members and relation between results of research and current specifications for design; members subjected to flexure, axial compression, combined flexure and axial load, combined flexure and shear, and bond. I, II; 1 unit. Prerequisite: Bachelor of Science degree in Civil Engineering or architecture with courses in structures and reinforced concrete design. Siess, Sozen.

368. **Prestressed Concrete.** Principles of linear prestressing; study of materials used in prestressed concrete; design of simple beams on the bases of ultimate stresses and working loads; design of continuous prestressed concrete beams. I, II; ½ unit. Prerequisite: Civil Engineering 264. Khachaturian.

380. **Foundation Engineering.** Evaluation of subsoil conditions as they affect the behavior, proportions, and choice of type of foundations; bearing capacity

and settlement analyses; character of natural soil deposits; earth pressure theories and retaining wall analysis; slope stability. I, II; 1 unit. Prerequisite: Civil Engineering 210; senior standing.

383. **Soil Mechanics.** Identification, description, and classification of soils; index properties, weight-volume relationships; hydraulic properties; stress-deformation characteristics; ultimate strength; subsurface exploration; character of natural soil deposits. I; ¾ to 1 unit. Prerequisite: Graduate standing or consent of instructor. DEERE, IRELAND.

384. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; earth pressure and retaining walls; braced cuts; damage due to construction operations. II; ¾ to 1 unit. Prerequisite: Civil Engineering 383 or consent of instructor. DEERE, IRELAND.

385. **Engineering Aspects of Surficial Soils.** Use of geologic and pedologic information and airphoto interpretation techniques in the prediction of engineering properties of soils and the planning of engineering soil surveys. Field trip; estimated expense $5.00. I; 1 unit. Prerequisite: Civil Engineering 210 or consent of instructor. THORNBURN.

THE CLASSICS

The Department of Classics offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

The degree of Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the degree of Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. In all cases, the requirement of a master's thesis is waived; extra units of work in Greek or Latin are substituted for the thesis.

The degree of Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

The minimum grade-point average for admission to graduate study in the department is 3.5. All graduate students should take Greek or Latin 495-496, Bibliography and Criticism, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a mimeographed bulletin which may be obtained by applying to the head of the department, 138 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: J. L. HELLER (Head of Department), R. P. OLIVER, B. E. PERRY, A. TURYN.

Assistant Professors: A. L. BOEGEHOLD, R. E. PALMER.

Classics in Translation

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Classical Literary Traditions, I.** Greek literature from Homer to Aristotle. I; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Knowledge of Greek or Latin is not required. PERRY.

302. **Classical Literary Traditions, II.** Literary forms in the Alexandrian and Roman periods. II; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Knowledge of Greek or Latin is not required. PERRY.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 138 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. **Greek Versification.** Greek prosody: survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. I, II; 1 unit. Turyn.

411. **Hellenistic Literature.** I, II; 1 unit. Perry.

412. **Lucian and His Age.** I, II; 1 unit. Perry.

413. **Greek Lyric Poetry.** I, II; 1 unit. Turyn.

414. **Pindar and Bacchylides.** I, II; 1 unit. Turyn.

415. **Homer.** I, II; 1 unit. Turyn.

416. **Thucydides.** I, II; 1 unit. Heller.

423. **Aeschylus and Sophocles.** I, II; 1 unit. Perry.

424. **Euripides.** I, II; 1 unit. Turyn.

425. **Greek Drama: Comedy.** I, II; 1 unit. Turyn.

461. **Greek Archaeology.** Methods and principles of Greek archaeology, as exemplified in the study of pottery, sculpture, architectural remains, coins, and inscriptions. I, II; 1 unit. Prerequisite: One year of ancient history or consent of instructor. Knowledge of Greek not required.

495. **Bibliography and Criticism.** Same as Latin 495. Introduction to the methods and techniques of scholarship. I; ½ unit. Oliver.

496. **Bibliography and Criticism.** Same as Latin 496. II; ½ unit. Oliver.

499. **Thesis Research.** Same as Latin 499. Guidance in writing theses for advanced degrees. I, II; 0 to 4 units. Heller, Oliver, Perry, Turyn.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

318. **Elements of Technical Terminology.** Presentation and analysis of Greek and Latin prefixes, suffixes, and root-words basic in the vocabularies of modern science, especially botany, psychology, zoology, and medicine. I, II; ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent, or completion of twenty hours of science or architecture. Knowledge of Greek or Latin is not required. Heller.

391. **Readings in Greek Literature.** Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. I, II; ½ to 1 unit. Prerequisite: Two years of college Greek; consent of instructor. Staff.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge

of French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the degree of Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. Two of the four required units in Latin must be in courses numbered above 400; the other two units are Latin 311, 312, and 391. The required work in education consists of Education 311 and 312 and one unit selected from Education 301, 302, 303, 304. The electives may be in Latin, in Greek, in education, or, in exceptional cases, in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. L. Heller, 138 Lincoln Hall.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 138 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is four years of college Latin or equivalent.

400. **Beginning Latin for Graduate Students.** Basic grammar and vocabulary; practice in reading. Intensive course for graduate students who need to use Latin in their research. I; 4 hours. No graduate credit. OLIVER.

401. **Readings in Latin for Graduate Students.** Directed readings, largely in medieval and modern Latin. Designed for graduate students who need to use Latin in their research. II; 4 hours. No graduate credit. Prerequisite: Latin 400 or two years of high school Latin. HELLER.

409. **History of the Latin Language.** I, II; 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language. HELLER.

410. **Vulgar Latin.** I, II; 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language. HELLER.

411. **Latin Epigraphy.** I, II; 1 unit. Prerequisite: Three years of college Latin or equivalent; one year of ancient history. OLIVER.

412. **Latin Elegy.** I, II; 1 unit. OLIVER.

413. **Caesar.** I, II; 1 unit. TURYN.

414. **Lucan.** I, II; 1 unit. OLIVER.

415. **Lucretius.** I, II; 1 unit. PERRY.

416. **Vergil.** I, II; 1 unit. TURYN.

421. **Horace.** I, II; 1 unit. TURYN.

422. **Plautus and Terence.** I, II; 1 unit. TURYN.

423. **Latin Romance.** I, II; 1 unit. PERRY.

425. **Cicero.** I, II; 1 unit. TURYN.

426. **Tacitus.** The *Annales.* I, II; 1 unit. OLIVER.

427. **Roman Satire.** I, II; 1 unit. PERRY.

441. **Latin Paleography.** I, II; 1 unit. OLIVER.

462. **Topography and Monuments of Ancient Rome.** I, II; 1 unit. Prerequisite: One year of ancient history or consent of instructor.

495. **Bibliography and Criticism.** Same as Greek 495. Introduction to the methods and techniques of scholarship. I; ½ unit. OLIVER.

496. **Bibliography and Criticism.** Same as Greek 496. II; ½ unit. Oliver.

499. **Thesis Research.** Same as Greek 499. Guidance in writing theses for advanced degrees. I, II; 0 to 4 units. HELLER, OLIVER, PERRY, TURYN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Caesar and His Background.** Geography, history, and politics of the age of Caesar. Lectures and readings in the sources. Designed especially for the high school teacher. S; ½ unit. Prerequisite: One year of college Latin beyond the level of four years in high school.

311. **Advanced Latin Composition.** Practice in the writing of Latin prose. I; ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major. TURYN.

312. **Advanced Latin Composition.** II; ½ unit. Prerequisite: Latin 311. TURYN.

313. **Oral Latin.** Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Prerequisite: Latin 312 or consent of instructor.

391. **Readings in Latin Literature.** Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Livy, Horace, Vergil, Cicero's *Orations,* Seneca, Ovid, Cicero's *Essays,* Patristic Latin, Medieval Latin. I, II; ½ to 1 unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

COMMUNICATIONS

The graduate program leading to the degree of Doctor of Philosophy in Communications is administered by an interdisciplinary committee appointed by the Dean of the Graduate College. It provides a core program of study in communications and permits advanced specialization in a number of areas: process, content, and effects of the mass media, including their political, social, and economic aspects; advertising; interpersonal communication; psycholinguistics and linguistics.

The program is designed to apply the methods and disciplines of the social sciences, supported by the humanities, fine and applied arts, and natural sciences, to the basic problems of human communication. It is intended for students whose academic and professional experience qualifies them for advanced study in this area and whose plans for careers are such as to make this interdepartmental degree appropriate. Among such careers may be the teaching of communication subjects such as journalism, radio-television, and linguistics; scholarly research on the development, control, and ethics of the mass media, experimental research on public opinion measurement, advertising, communication effects, psycholinguistics, and semantics; executive jobs in government and industry requiring breadth, perspective, and a scholarly background.

Prerequisite to admission to this program is a broad background in the social sciences and humanities. If a student is lacking in the prerequisite background, he may be admitted probationally while he makes up the deficiency, but he may not count these courses among the twenty-four units required for the degree. The applicant is advised that many of the advanced courses have introductory courses as prerequisites. Attention is also called to the general usefulness to the applicant of an introductory course in statistics.

A candidate for the degree of Doctor of Philosophy in Communications must complete at least twenty-four units of graduate work. Programs are individual but must provide both a broad introduction to the field of communications with its related disciplines (requirements 1, 2, and 4, below), and a specialization in a subfield of communications (requirements 3 and 5). A minimum of sixteen units are taken in course work and eight units in thesis credit. The following are the detailed requirements to be met in the student's course of study.

(1) The Communications proseminar (courses 471 and 472) is required of all students for two units credit.

(2) One unit must be selected from the following courses (Group A): Communications 444, 446, 462, 467, 468, 470, 473, 474, and 481, and one unit from the following courses (Group B): Communications 425, 426, 442, 456, 475, 476, 479, 300, 302, 370, and 373.

(3) The remaining units of course work should contribute to an area of specialization in communications. The following are suggested areas: theory of communications, philosophy of communications, communications policies and structures, public opinion and attitude formation, advertising (illustrated by Group A above); interpersonal communication, psycholinguistics, linguistics, experimental phonetics (illustrated by Group B above). Upon occasion other specializations may be developed subject to the approval of the Committee on Graduate Study in Communications. Of this specialization two units bearing graduate credit must be taken in courses in research methods which are appropriate to the area of specialization; such courses may deal with the philosophical, historical, mathematical, or technical aspects of inquiry and research.

(4) Completion of either a sole minor of four units in a discipline other than communications in courses chosen to complement the student's special field within communications; or a split minor with three units in a discipline other than communications and three units in a field of communications outside the area of concentration. (If the concentration is in Group A, the minor must be in Group B, and *vice versa.*) Courses cross-listed in communications may not be counted toward a minor in a discipline other than communications.

(5) Eight units credit must be earned in Communications 499 by the submission of a satisfactory dissertation.

(6) The language requirements of the Graduate College must be met.

(7) The candidate must pass a preliminary written and oral examination.

(8) The candidate must pass a final oral examination centered on but not restricted to the field of the dissertation.

The student's special adviser is appointed as soon as the student has decided on an area of specialization, but the general adviser must approve the student's program during the first eight units of the student's program.

Minor. A candidate for the degree of Doctor of Philosophy who wishes to minor in communications should select four, three, or two units (according to the requirements of his major department) from the list below: Communications 471 and 472 are recommended for the student desiring a broad survey of theory and research in this area. Candidates minoring in communications are expected to have a social science background sufficient for such courses as they choose. A student having doubts as to the adequacy of his background should consult the chairman of the administrative committee, who will also advise him as to the desirable combinations and sequences of courses.

Inquiries for further information should be addressed to the chairman of the administrative committee, Professor Dallas W. Smythe, 119 Gregory Hall. A brochure describing the graduate program in communications and the kinds of professional careers for which it gives training may also be obtained from Professor Smythe.

THE INSTITUTE OF COMMUNICATIONS RESEARCH

The Institute is an interdisciplinary group studying problems relating to the communications process and its role in society. Its staff consists of research professors, usually appointed part time in the Institute and part time in related departments, and graduate student research assistants. The research backgrounds and interests of the staff range from linguistics, through psychology and the other social sciences, to journalism and other disciplines concerned with the mass media. Graduate students in the communications program frequently participate in the

research activities of the Institute of Communications Research and have access to the research personnel and facilities of this unit of the College of Journalism and Communications. Inquiries concerning the Institute of Communications Research should be addressed to its director, Professor Charles E. Osgood, 120 Gregory Hall.

GRADUATE TEACHING FACULTY

Professors: D. W. Smythe (Chairman of Committee on Graduate Study in Communications), G. Fairbanks, L. S. Hultzén, H. R. Kahane, C. E. Osgood, T. B. Peterson, C. H. Sandage.
Associate Professors: G. Gerbner, J. W. Jensen, W. J. McGuire.
Assistant Professor: H. S. Maclay.
Lecturer: H. J. Skornia.

COURSES FOR GRADUATES

425. **Psycholinguistics.** Same as Humanities 425 and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. I or II; 1 unit. Prerequisite: Consent of instructor. Osgood.

426. **Research Seminar in Psycholinguistics.** Same as Humanities 426 and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. I or II; ½ to 1 unit. Prerequisite: Communications 425; consent of instructor. Maclay, Osgood.

442. **Seminar in Phonetics.** Same as Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. I or II; 1 unit. Prerequisite: Consent of instructor. Hultzén.

444. **Seminar in Public Opinion.** Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. I, II; 1 unit.

446. **Opinion Polling Analysis.** Same as Sociology 446. The study of current polling practices, organizations, and findings; evaluation of results in terms of the prediction and interpretation of social behavior. I, II; 1 unit.

456. **Psychology of Social Communication.** Same as Psychology 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. I or II; 1 unit. Prerequisite: Psychology 451 or equivalent, or consent of instructor. McGuire.

462. **Seminar in Radio and Television.** Same as Radio-Television 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. I; 1 unit. Skornia.

467. **The Political Economy of Communications, I.** Same as Journalism 467. Analysis of theory and problems concerning such social agencies of communication as newspapers, magazines, books, postal service, and telegraph, with special emphasis on their policies and structures. I; 1 unit. Prerequisite: Economics 102 and 103, or 108, or consent of instructor. Smythe.

468. **The Political Economy of Communications, II.** Same as Journalism 468. Analysis of theory and problems concerning such social agencies of communi-

cation as telephone, radio services (including television), and motion pictures, with special emphasis on their policies and structures. II; 1 unit. Prerequisite: Communications 467. SMYTHE.

470. **Communications and Popular Culture.** Same as Journalism 470. Problems of cultural analysis related to the media of communications; social implications of communications research. II; 1 unit. GERBNER.

471. **Proseminar in Communications, I.** Same as Journalism 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. I; 1 unit. SMYTHE and others.

472. **Proseminar in Communications, II.** Same as Journalism 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. II; 1 unit. MACLAY and others.

473. **History and Theory of Freedom of the Press.** Same as Journalism 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. I; 1 unit. JENSEN.

474. **Government and Mass Communications.** Same as Journalism 474. Communications and political order; theory and structure of democratic and totalitarian communications systems; relationship between government and mass communications in the modern world. II; 1 unit. JENSEN.

475. **Experimental Phonetics, I.** Same as Humanities 475 and Speech 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. I; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

476. **Experimental Phonetics, II.** Same as Humanities 476 and Speech 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. II; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

479. **Seminar in Experimental Phonetics.** Same as Humanities 479 and Speech 479. Advanced consideration of experimental research in the physiological, acoustical, and psychophysical aspects of speech and hearing. Extensive survey of current literature. S; 1 unit. Prerequisite: Communications 475 and 476, or consent of instructor. FAIRBANKS.

481. **Advanced Advertising Principles.** Same as Advertising 481 and Marketing 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Communications 481 and Advertising 388. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communication.** Same as Advertising 482 and Marketing 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

490. **Special Topics in Communications.** I, II; ½ to 2 units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. Students may re-register for a total of eight units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications and of thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Introduction to Linguistics.** Same as Humanities 300. An introduction to the science of descriptive linguistics. I; ½ to 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

302. **Comparative Linguistics.** Same as Humanities 302. An introduction to the historical aspects of language. II; ½ to 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

370. **Language, Culture, and Society.** Same as Anthropology 370 and Humanities 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. I or II; ½ to 1 unit. MACLAY.

373. **Phonetics and Phonemics.** Same as Humanities 373 and Speech 373. Methodologies of phonetics, with special application to English; general principles of phonemic interpretation. I or II; ½ to 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Speech 301. HULTZÉN.

392. **Research Methods for Press, Radio, and Television.** Same as Journalism 392. An introduction to relevant research methods and practices for mass media personnel who need to use research as a tool of management and policy, order research, and interpret research. Lectures, readings, and laboratory practice. II; ½ unit.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction, each calling for a somewhat different undergraduate preparation and graduate program. Students majoring in dairy science may select one of these areas of study for the master's or doctor's degree. Students interested in the economics of milk production normally major in the Department of Agricultural Economics. For the Master of Science degree, students may elect to confine their work entirely to the major. If a minor is chosen, it must be in another department. For the Doctor of Philosophy degree, students may select a sole minor in another department, or a first minor and a second minor, the first of which may be in a field closely allied to the area of specialization of the major; the second must be taken in another department. The amount of graduate credit required in each case is dependent upon the specifications of the Graduate College and the department in which the minor is chosen. Students selecting dairy bacteriology or dairy biochemistry as areas of specialization for the major in dairy science should expect and be prepared to elect some branch of chemistry as one of the minors for an advanced degree.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.5.

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. A faculty adviser specifies course requirements and their sequence and directs the research and the preparation of the thesis. Candidates for the degree of Master of Science must complete one-half unit of Dairy Science 490 and two units of Dairy Science 499. For the degree of Doctor of Philosophy, one and eight units, respectively, of these courses are required. Other course require-

ments depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the degree of Master of Science are expected to complete an acceptable thesis unless conditions warrant waiver of this requirement, which may be done only upon petition to and permission of the Dean of the Graduate College. All students expecting to continue graduate studies should fulfill the thesis requirement for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science is a departmental requirement for the degree of Master of Science.

For a minor in dairy science, students should select a minor adviser in the area of study of their choice and determine with that adviser the specific courses required. For the degree of Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the degree of Doctor of Philosophy, the minimum requirements for a sole minor are four units of dairy science of which two units must be in courses numbered 400 or higher; for a first minor, three units in dairy science; and for a second minor, two units in dairy science.

GRADUATE TEACHING FACULTY

Professors: G. W. Salisbury (Head of Department), W. O. Nelson, R. Touchberry, N. VanDemark.

Associate Professors: H. P. Broquist, K. A. Kendall, B. L. Larson.

Assistant Professors: R. E. Brown, J. H. Byers, L. R. Hays, M. J. Wolin.

COURSES FOR GRADUATES

402. **The Microbiology and Physiology of Ruminant Nutrition.** The physiological and microbiological aspects of ruminant digestion and their influence on the metabolism of the extraruminal tissues; interpretation of nutritive requirements in terms of rumen microbial activities and evaluation of research techniques. I; ¾ unit. Prerequisite: Bacteriology 300, Chemistry 350, 355, or equivalent. Brown, Nelson.

408. **Physiology of Lactation.** The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. II; ½ to 2 units. Hays.

411. **Population Genetics and Animal Breeding.** Same as Animal Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. II; 1 unit. Prerequisite: Dairy Science 110 or equivalent. A knowledge of elementary algebra is essential. Touchberry.

430. **Physiology of Mammalian Germ Cells.** A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. II; 1 unit. Prerequisite: Dairy Science 330, Animal Science 406, and Chemistry 350, or consent of instructor. Salisbury, VanDemark.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy 440, Animal Science 440, Horticulture 440, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler

designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. JACOB.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy 441, Animal Science 441, Horticulture 441, and Veterinary Medical Science 441. A continuation of Dairy Science 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Dairy Science 440 or equivalent. JACOB.

450. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. I, II; ½ to 2 units. Prerequisite: Ten hours of advanced bacteriology and/or chemistry; consent of instructor. NELSON, WOLIN.

453. **Dairy Bacteriology Seminar.** Discussion of current literature and problems in dairy bacteriology. II; ½ unit. NELSON, WOLIN.

490. **Dairy Science Seminar.** Current literature relating to various phases of dairy science. I, II; ½ unit. SALISBURY.

493. **Special Problems.** Individual investigations in any phase of dairy science. I, II; ½ to 2 units. BROQUIST, BROWN, BYERS, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOLIN.

499. **Thesis Research.** I, II; 0 to 4 units. BROQUIST, BROWN, BYERS, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** I, II; ½ to 1 unit. Prerequisite: Approval of head of department. BROQUIST, BROWN, BYERS, HAYS, KENDALL, LARSON, NELSON, SALISBURY, TOUCHBERRY, VANDEMARK, WOLIN.

305. **Genetics and Animal Improvement.** Same as Animal Science 305. The principles of heredity and their application to the problems of animal improvement. II; ¾ unit. Prerequisite: Dairy Science 110 or equivalent. RASMUSEN, TOUCHBERRY.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. I; ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. VANDEMARK.

334. **Marketing Dairy Products.** Same as Agricultural Economics 334 and Marketing 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5.00. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

350. **Advanced Dairy Bacteriology.** A systematic study of the cultural, physiological, and biochemical properties of microorganisms; the application of principles to problems concerning the microflora of milk, milk products, and the bovine digestive system. I; 1 unit. Prerequisite: Chemistry 122 and 132; Microbiology 100 and 101, or equivalent. NELSON, WOLIN.

381. **Dairy Biochemical Laboratory Methods.** Theory and application of dairy biochemical laboratory methods: proximate analysis, spectrophotometry, chromatography, protein separation, microtechniques, micro respiration, and others. II; 1 unit. Prerequisite: Quantitative analysis; organic chemistry; consent of instructor. Biochemistry is recommended. BROQUIST, LARSON.

DANCE

The Dance Division offers a program of graduate study leading to the degree of Master of Arts in Dance. This program offers advanced work in choreography, dance production, and pedagogy, with emphasis on the related fields of art, music, and theater, and is administered by the supervisor of the Dance Division and an Interdisciplinary Committee composed of representatives from the Departments of Art and Speech and the School of Music.

Admission requirements for a major in this field are: (1) a minimum grade-point average of 3.5; (2) twenty-four semester hours of approved undergraduate credit in dance (at least eight hours), art, music, theater, and physical education; (3) thirty-six semester hours in humanities (literature, language, and philosophy), natural sciences (biological and physical sciences), and social sciences (history, political science, psychology, anthropology, sociology, education). Applicants lacking a portion of the prerequisites under item (2) may substitute certified experience in dance not to exceed eight semester hours.

Satisfaction of the general requirements for admission to the Graduate College and to this program does not in itself necessarily qualify the student as a degree candidate. The supervisor of the Dance Division also reserves the right to accept for advanced study only those students whose preparation in dance has been obtained in certain approved institutions.

Of the eight units required for the Master of Arts degree, a minimum of four must be in dance, or (subject to the approval of the supervisor) in dance and related areas such as art, music, theater, speech, physical education, and recreation; two units must be in one or more of the following fields: English, history, philosophy, anthropology, psychology, sociology, radio-television. The remaining two units are for the presentation of an acceptable thesis (Dance 499) and the accompanying noncredit course Dance 490, Seminar. The thesis may be waived, with the approval of the adviser, but in lieu thereof the candidate must submit two additional units plus a recital of solo and group dances which he has choreographed and staged.

Not later than mid-point in the student's proposed program, the candidate's work is reviewed in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The supervisor of the Dance Division may extend the residence requirement (or increase the total requirements) at this time or any other time, if this seems warranted.

GRADUATE TEACHING FACULTY

Associate Professor: Margaret Erlanger (Supervisor of Division).
Assistant Professor: B. B. Johnston.
Instructor: W. W. Ward, Jr.

COURSES FOR GRADUATES

400. **Problems in Dance Education.** Basic historical, philosophical, and scientific foundations and developments in dance education; teaching methods; development of compositional problems; creative methods of instruction; organizational problems of dance groups and public dance performance. I, II; 1 unit. Prerequisite: Dance 243, or Dance 244, or equivalent. Erlanger.

401. **Choreography.** Experience in choreographing a minimum of a solo and a group composition to be presented at the end of the semester. I, II; ½ to 2 units. Prerequisite: Dance 345 or equivalent. Students may re-register for a maximum of two units with the permission of the supervisor of the Dance Division. Johnston, Ward.

490. **Dance Seminar.** Presentation of thesis studies, discussions, critical analysis

of problems, informal lectures, and demonstrations by professional guests. I, II; no credit. STAFF.

499. **Thesis Research.** Preparation of thesis in dance. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **History of Dance.** A survey course tracing dance from its beginnings in primitive societies to its present art form. I, II; ½ unit. Prerequisite: Senior or graduate standing and/or consent of instructor. ERLANGER.

345. **Dance Production Workshop.** Experience in choreography and production of group compositions with special emphasis on staging, lighting, and costuming. I, II; ½ unit. Prerequisite: Dance 164 or equivalent, senior or graduate standing, and/or consent of instructor. JOHNSTON, WARD.

346. **Theory and Philosophy of Dance.** A study of the relationship of aesthetic principles and dance theory to a philosophy of dance in education and of dance as a performing art. I; ½ unit. Prerequisite: Senior or graduate standing and/or consent of instructor. ERLANGER, JOHNSTON.

ECONOMICS

The Department of Economics offers graduate work leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy.

A student who applies for admission to graduate study in economics must have a grade-point average of 3.5 or better. If he plans to major in general economics, he must have completed twenty-seven hours of undergraduate work in social science, at least fifteen of which are in economics, including courses in principles of economics and statistics. If he wishes to major in quantitative economics, he must have completed nine hours of undergraduate work in economics, and is strongly advised to have completed calculus. A student who has not completed these entrance requirements must make up the deficiencies during his first year of graduate study, usually without receiving graduate credit. The Department of Economics requires that the results of the Graduate Record Examination Aptitude Test accompany application for admission to the Graduate College, except that under unusual circumstances the student may secure permission from the Department of Economics to take this examination during his first semester of residence. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, 22 Nassau Street, Princeton, New Jersey.

The candidate for an advanced degree in economics may specialize in one of the areas of general economics or in quantitative economics. The areas of general economics include: economic theory, income theory and policy, history of economic thought, comparative economic systems, the economics of underdeveloped countries, public finance and taxation, monetary theory and policy, international economics, economic history, labor economics, statistics, econometrics, business cycles and forecasting, transportation, economic education, and the relations of government and business. Quantitative economic analysis is concerned with linear programming, game theory, statistics, mathematical economics, econometrics, input-output analysis, data processing methods, activity analysis, etc.

Minor. A student majoring in another department who wishes to minor in economics must have taken a minimum of twelve hours of undergraduate courses in social science, eight of which are in economics, including a course in principles. A student who chooses economics as a minor for the Doctor of Philosophy degree must take at least two units of work in this department.

Degrees of Master of Arts or Master of Science. The requirements for a

master's degree in general economics are eight units, including two units of eco nomic theory (Economics 400-401 or 402-403) and two units of thesis researcl (Economics 499). If a minor is taken outside the department, at least one uni is required. For a master's degree in quantitative economics, the requirements ar eight units, including two units of economic theory and prescribed courses ir operations research, statistics, mathematical economics, and income analysis; a thesis is not required.

Degree of Doctor of Philosophy. The requirements for a Doctor of Philos ophy degree in economics are sixteen units, including at least three units of eco nomic theory at the 400 level, and eight doctoral dissertation units. Credit earnec toward a master's degree is counted in this total. The course requirements for a Ph.D. in quantitative economics are specified in detail; in general economics th student is allowed, within limits, to choose his own area of concentration and i advised concerning appropriate courses. He is required to pass examinations ir two foreign languages, an oral and written preliminary examination prior tc beginning his dissertation research, and an oral final examination covering thi research. The preliminary examination covers (1) contemporary micro and macr economic theory, involving both literary and mathematical expositions, and abilit to understand the literature appearing currently in the journals in the field (2) the history of economic thought, and (3) other fields of economics or allie subjects to be selected with the approval of the adviser. A two-unit minor mus be taken outside of the department.

GRADUATE TEACHING FACULTY

Professors: J. F. Bell (Head of Department), H. K. Allen, V L. Bassie H. J. Brems, W. E. Chalmers, J. F. Due, R. Ferber, D. P. Flanders, H. M. Gray, R. W. Harbeson, D. L. Kemmerer, D. P Locklin, E. B. McNatt, W. McPherson, W. A. Neiswanger D. W. Paden, J. B. Parrish.

Associate Professors: Grace Beckett, R. Brandis, D. R. Hodgman, G Kleiner, J. L. McConnell, L. E. Wagner, Janet L. Weston.

Assistant Professors: F. W. Kohlmeyer, W. W. McMahon, P. Wells, T. A Yancey.

Instructor: F. R. Shupp.

COURSES FOR GRADUATES

400. **General Economic Theory.** A preliminary survey of business, labor, government, monetary, and other institutional aspects of economics, followed by a more extended analysis of theoretical economics and the application o this theory to some of the problems raised in the preliminary survey. Intended for students whose minor is economics and other students who have only the minimum preparation for graduate study in economics. I; 1 unit Prerequisite: Economics 102 and 103, or 108. Flanders.

401. **General Economic Theory.** A preliminary survey of business, labor, government, monetary, and other institutional aspects of economics, followed by a more extended analysis of theoretical economics and the application of thi theory to some of the problems raised in the preliminary survey. Intendec for students whose minor is economics and other students who have only the minimum preparation for graduate study in economics. II; 1 unit. Prerequisite: Economics 102 and 103, or 108. Flanders.

402. **Economic Theory.** From the fundamentals laid by classical and neo-classica writers, this course develops modern micro-economic and macro-economic theory: demand and cost, market forms, price policy, non-price competition general equilibrium theory, and input-output analysis. I; 1 unit. Prerequi-

site: Twenty-seven hours of undergraduate work in social sciences, fifteen of which must have been in economics; the work in economics must include a course in the principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite. BREMS.

403. **Economic Theory.** From the fundamentals laid by classical and neo-classical writers, this course develops modern micro-economic and macro-economic theory: employment, wage, interest and monetary theory, the theory of investment, the theory of consumption, the theory of steady advance, and the theory of welfare. II; 1 unit. Prerequisite: Twenty-seven hours of undergraduate work in social sciences, fifteen of which must have been in economics; the work in economics must include a course in the principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite. BREMS.

404. **Theory of Aggregate Income.** A comprehensive introduction to the theory of income and employment with emphasis upon fluctuation and growth. I, II; 1 unit. Prerequisite: Graduate standing. PADEN.

405. **The Theory of Capital and Interest.** A comprehensive and critical examination of the theory of capital and interest as the subject has been developed by the leading English and continental writers. Special attention is given to the optimal investment decision of the firm, capital accumulation, and the efficient utilization of society's resources, and to the relation between capital and interest. II; 1 unit. Prerequisite: Economics 403 or consent of instructor. CAMPBELL, WELLS.

406. **A History of Economic Thought.** Development of economic thought from early times to the present. I; 1 unit. BELL.

407. **A History of Economic Thought.** Development of economic thought from early times to the present. II; 1 unit. BELL.

410. **Comparative Economic Systems.** The economics of capitalism, socialism, communism, and fascism. I; 1 unit. MCCONNELL.

411. **Economics of Underdeveloped Countries.** Economic history, population and labor, national income, consumption and investment, agriculture, and land tenure systems as they relate to national and international plans for economic development of the backward areas. Emphasis on adaptation of standard tools of economic analysis to problems of development. Case studies of Brazil, India, China, and Japan. Special attention is given to cultural pre-conditions for economic progress. II; 1 unit. Prerequisite: Economics 102 and 103, or 108. MCCONNELL.

414. **Public Finance.** An analysis of the economics of public expenditures, administration of public funds, intergovernmental fiscal relations, non-tax revenues, public borrowing, debt management, and fiscal policy. I; 1 unit. Prerequisite: Six hours of economics. ALLEN, DUE.

415. **Economics of Taxation.** An analysis of the economics of taxation, with respect to distribution of tax burden, incidence of taxation, and the place in the tax system of the major taxes, particularly the personal and corporation income, sales and excise, property, and death taxes. II; 1 unit. Prerequisite: Six hours of economics. ALLEN, DUE.

420. **Monetary Theory and History.** A critical examination of monetary theories and their neoclassical antecedents. Among the topics considered are the rate of interest, the level of income, the level of employment, changes in the general level of prices, and the relationship of monetary and fiscal policy. I; 1 unit. Prerequisite: A course in income or employment theory, or consent of instructor. HODGMAN.

425. **National Economic Accounts.** Four systems of economic accounting — income

and product, balance of payments, flow-of-funds, and input-output — each designed to provide a comprehensive picture of different aspects of the national economy, are analyzed. Consideration is also given to national balance sheets and statements of national wealth; to international comparisons of economic accounts; and to the use of these accounts as a theoretical and empirical framework for regional analysis. The present status of the accounts and the problems of an integrated system of accounts are evaluated in terms of their theoretical orientation and applicability for economic analysis and policy formulation. II; 1 unit. Prerequisite: Six hours of economics and/or consent of instructor. WAGNER and others.

428. **International Economics and Finance.** Analysis of international monetary standards; of their effects on domestic income levels, finance, and central bank problems. I; 1 unit. KLEINER.

429. **International Economics and Finance.** Governmental policies designed to maximize domestic welfare through international exchange of goods and services and through international investment. II; 1 unit. KLEINER.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 336. I; 1 unit. KEMMERER.

437. **Research in American Economic History.** Readings on special problems in primary sources, monographs, and learned journals; training in the use of bibliographical materials and in principles of historical method and research, and the application of economic principles to the study of American economic history. Preparation of a short term paper based exclusively on primary sources. II; 1 unit. Prerequisite: Economics 336 or 436, or equivalent, and a course in economic principles, or consent of instructor. KEMMERER.

438. **Economic History of Europe.** The major lines of development since 1450; comparative study of forces and institutions inimical or favorable to growth; selected readings on organization of economic activity, role of governments and the entrepreneur, commercial policy, monetary systems, land tenure, process of capital formation, and industrialization, etc. II; 1 unit. Prerequisite: Consent of instructor.

440. **Labor Economics.** Same as Labor and Industrial Relations 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. I; 1 unit. Prerequisite: Six hours of economics. MCNATT.

441. **Labor Economics.** Same as Labor and Industrial Relations 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. II; 1 unit. Prerequisite: Six hours of economics. MCNATT.

442. **Collective Bargaining.** Same as Labor and Industrial Relations 442. The development of a theory of the continuing interactions between union and management. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and the governmental process. I, II; 1 unit. Prerequisite: Consent of instructor. CHALMERS.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Labor and Industrial Relations 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievances handling, analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. I, II; 1 unit. Prerequisite: Consent of instructor. McPherson.

444. **Economics of Manpower Resources.** Same as Labor and Industrial Relations 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. I; 1 unit. Prerequisite: Graduate standing or consent of instructor. Parrish.

447. **Labor Union Organization and Administration.** Same as Labor and Industrial Relations 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. I, II; 1 unit. Prerequisite: Major in social science or consent of instructor. Garman.

470. **Economic Statistics.** Basic concepts and methods of statistical analysis as applied in economics and business. I; 1 unit. Prerequisite: Consent of instructor. Neiswanger.

471. **Economic Statistics.** Methods of analysis, problems of aggregation and index numbers, nature of economic time series and problems of analysis; input-output analysis and special problems of functional analysis in economics. II; 1 unit. Prerequisite: Economics 470 or nine hours of applied or theoretical statistics. Neiswanger.

472. **Econometrics.** Same as Mathematics 472. Application of the principles of mathematical statistics to estimation of economic relationships. II; 1 unit. Prerequisite: Mathematics 363; consent of instructor. Yancey.

473. **Economic Forecasting.** Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgment in evaluating current information; selecting critical factors, and appraising the validity of analytical techniques. II; 1 unit. Prerequisite: One year of statistics. Bassie.

480. **Seminar in the Relations of Government and Business.** Problems in the relations of government and business. Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. I; 1 unit. Gray.

481. **Seminar in the Relations of Government and Business.** Problems in the relations of government and business. Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. II; 1 unit. Gray.

484. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. I; 1 unit. Locklin.

485. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. II; 1 unit. Locklin.

490. **Individual Study and Research.** Directed reading and research. I, II; ½ to 1 unit. Staff.

499. **Thesis Research.** Required of all students writing master's and doctor's theses in economics. I, II; 0 to 4 units. Master's theses, FLANDERS; doctor's theses, BELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Intermediate Economic Theory and Analysis.** A development of the leading theories and analyses of value and distribution. Problems and policies of price determination of both the firm and the industry and factor pricing are presented at the intermediate level of analysis. I, II; ½ unit. Prerequisite: Economics 102 and 103, or 108 and 109. BELL, DUE.

301. **Monetary and Employment Theory.** Monetary theory including various versions of the quantity theory of money; the modern theory of the determination of the level of income and employment; theories of money and interest; fiscal and monetary policy; criteria, proposals, critique. I, II; ½ unit. Prerequisite: Finance 250. WELLS.

304. **Mathematical Analysis in Economics.** Designed to acquaint the student with rudimentary mathematical techniques and their application to economic analysis. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108 and 109; Mathematics 111 or 112. BREMS.

306. **History of Economic Thought.** A study of the development of economics. Contributions of schools of thought and individual writers are examined as they influenced economic thought and national policy. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. BELL.

312. **The Soviet Economy.** Analytical survey of Soviet economic development; structure and performance of the economy; problems of planning and control. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HODGMAN.

313. **Economics of Consumption.** Analysis of population, personal income distribution, consumption theories, savings and price movements; aggregate consumption expenditures and consumer choice; applications in the areas of laws affecting consumers, credit and tax policies. Credit not given for both Economics 213 and 313. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MILLICAN.

326. **Theories and Policies of International Commerce.** Analysis of international trade theories, classical and recent; international commercial policies, past and current; economic development in selected world regions; international commercial agreements and conferences; foreign trade policy of the United States. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. BECKETT.

328. **Latin-American Economic Problems.** Economic problems of commerce, finance, transportation, mining, agriculture, and industry in Latin America; Latin-American and international economic relationships. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108, or consent of instructor. BECKETT.

329. **Commerce and Industry in South America.** A study of the economic development of the countries of South America. Specialization, characteristics of economic activity, growth of manufacturing; foreign exchange mechanism, balance of payments adjustment, exporting and importing. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; consent of instructor. BECKETT.

335. **American Financial History.** American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banks and of other financial institutions, and the financing of major wars. II; ½ to 1 unit. Prerequisite: Finance 250. KEMMERER.

336. **American Economic History.** Westward movement; growth of industry, agri-

culture, commerce, finance, transportation, trust movement, and labor since 1790. I, II; ½ to 1 unit. KEMMERER.

337. **Economic History of American Agriculture.** Same as Agricultural Economics 337 and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. Graduate students who take this course for one unit credit are required to do extra work. The student writes a scholarly paper on some approved topic in agricultural history. I; ½ or 1 unit. Prerequisite: a college level course in basic economics or American history.

338. **European Economic History.** Analysis of far-reaching changes since 1500 in commerce and industry, transportation, money and banking, agriculture, social and institutional structures, and the role of national states. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108, or consent of instructor. KOHLMEYER.

342. **Economics of Social Security.** Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MCNATT.

343. **Collective Bargaining.** Emergence of collective bargaining in American industry; national labor policy and bargaining; impact of bargaining on union and management structures and policies; bargaining processes and techniques; the labor agreement including contract provisions, grievance procedures, arbitration; economic consequences of bargaining; case studies of union-management relationships and problems. II; ½ to 1 unit. Prerequisite: Economics 240. PARRISH.

344. **The Law and Labor.** Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; Economics 240. MCNATT.

346. **Foreign Labor Movements.** Same as Labor and Industrial Relations 346. Analysis of the history, organization, economic policies, political programs and domestic, international, and contemporary influence of the labor movements of Great Britain, Sweden, Germany, France, Latin America, and Russia. I; ½ to 1 unit. Prerequisite: Economics 240. CHALMERS.

371. **Applied Problems in Sampling.** Design of various types of samples useful in economic and business research; cost limitations and design of samples; sources of bias and sampling methods; interpretation of results; practical experience in conducting a complete sampling survey as a class project. II; ½ unit. Prerequisite: Economics 170 or a similar introductory course in statistics. NEISWANGER, YANCEY.

372. **Operations Research.** Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of probability theory, linear programming, statistical management controls, queuing theory; business policy and statistical decisions. I; ½ to 1 unit. Prerequisite: Economics 170 and Management 101, or consent of instructor. SHUPP.

374. **National Income and Business Forecasting.** The development of the national economic accounts and their use in forecasting business conditions for the economy as a whole and for the individual firm. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. PADEN.

375. Business Cycles and Economic Growth. An analysis of the causes of economic instability, the requirements for economic growth in the national economy, and a consideration of public policy relating to instability and growth. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. PADEN.

379. Elements of Econometrics. The formulation of hypotheses concerning economic relationships, different types of models, the identification and statistical testing of relations, and the efficient computation of numerical estimates. II; ½ to 1 unit. Prerequisite: One year each of statistics and economic theory; consent of instructor. YANCEY.

382. Economics of Highway Transportation. The organization, economic characteristics, and regulation of commercial motor transportation; development and management of the highway network; highway finance, with special attention to problems of user charges and cost allocation; the transportation problems of urban areas. II; ½ unit. Prerequisite: Economics 102 and 103, or 108; junior standing. HARBESON.

384. Economics of Transportation. Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. I, II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HARBESON, LOCKLIN.

385. Economic Problems of Commercial Air Transport. Study of air transport with particular reference to questions of public policy, system of regulation, and regulatory policy. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. LOCKLIN.

386. Current Transportation Problems. An analytical and critical study of selected problems of current interest in transportation. II; ½ to 1 unit. Prerequisite: Economics 384. HARBESON.

389. Industrial Competition and Monopoly. The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership as alternatives to the antitrust approach. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. HARBESON.

Note: See also Business Administration 373, Electronic Data Processing for Business.

EDUCATION

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology, elementary school teaching, guidance and counseling (including rehabilitation counseling), history and philosophy of education, home economics education, industrial education, research methods, secondary school teaching, or school psychology.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher, and undergraduate preparation appropriate to advanced study in the chosen major.

Degree of Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College pertaining to admission, registration, degree requirements, grades, residence, majors and minors, foreign language, and theses (see pages 15-21), the following regulations apply to programs leading to the degree of Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of no more than two units (Education 499), is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required, and may be demonstrated either by satisfactory grades in required courses or by satisfactory completion of proficiency examinations on those courses. Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required.

Degree of Master of Science in the Education of the Deaf. One of the following prerequisites is necessary for admission: (1) a bachelor's degree in elementary or special education (other than education of the deaf), or (2) a bachelor's degree in education of the deaf from an accredited training center for teachers of the deaf.

Candidates for this degree must earn a minimum of eight units as follows:

(1) Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required.

(2) For those students qualifying under prerequisite (1), Education 417, one unit; Education 319, one or one and one-half units; Education 320, one to two units; Speech 301, one-half unit; Speech 395, one-half unit; and Speech 385, one-half unit, are required. For those students qualifying under prerequisite (2), Education 418, one unit, and Education 449, one unit, are required.

(3) Elective courses should be chosen from Education 381, 412, 425, 426, 430, 440, 456, 460; Psychology 443, 461; Speech 375, 388, 488, 489.

The advisers for candidates for this degree are Professors S. A. Kirk, J. J. Gallagher, and Herbert Goldstein, 1003 West Nevada Street.

Degree of Master of Science in the Education of Mentally Handicapped Children. The following are required for admission: Courses sufficient to meet the requirements for an Illinois Teacher's Certificate and Education 220, 231, and Speech 208.

Candidates for this degree must earn a minimum of eight units as follows:

(1) Required courses: Education 311, 312, 322, 323, 417, 426, and two courses chosen from Education 301, 302, 303, and 304.

(2) Elective courses chosen from Education 390, 411, 412, 433; Psychology 338, 406, 411, 445, 461, 467, 493, 494; Speech 385, 388.

The advisers for candidates for this degree are Professors S. A. Kirk, J. J. Gallagher, and Herbert Goldstein, 1003 West Nevada Street.

Degree of Doctor of Philosophy. A student who wishes to become a candidate for the degree of Doctor of Philosophy with a major in education must (1) have met the academic requirements for the degree of Master of Arts or Master of Science in Education and (2) have written a thesis. Applicants for admission should present credentials well in advance of the date for their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the student is accepted by an adviser.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Degree of Master of Education.

Admission. In addition to general requirements, the credit presented for admission must include sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

Residence. At least four units must be earned while the student is in residence

on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

Program. Each candidate for the Master of Education degree works under the direction of a faculty adviser who helps him plan the program of study he will follow. This program must total at least eight units of course work, including four units in education. Education 311 and 312 and two courses chosen from Education 301, 302, 303, and 304 are required, except that students who pass proficiency examinations in these courses are excused from this requirement.

There may be one or two minors with a maximum of four units credit. In general, candidates for the Master of Education degree are expected to take at least two units in fields other than education. This provision is especially applicable to students in secondary education. The general requirements governing minors apply except that courses at the 200 level may be recognized for minor credit. Registration for credit in 200-numbered courses is subject to prior approval of the Dean of the Graduate College. Credit is computed at the rate of one-fourth unit for each semester hour, with two units as the maximum allowed for credit in 200-numbered courses. Credit earned in such courses can not be counted toward requirements for the degrees of Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Advanced Certificate in Education.

Admission. A master's degree from an accredited institution, plus a minimum of two years professional employment in education with a record of successful performance, constitutes the minimum requirement for admission.

Residence. The residence requirement for the Advanced Certificate is similar to that for the Master of Education degree.

Program. The Advanced Certificate in Education requires the satisfactory completion of a year of specialized professional study. Of the eight units of course work required at least four must be in courses at the 400 level. Students who have not previously taken Education 311 and 312, or equivalents, are required to take these courses or pass proficiency examinations on them. A similar provision applies with respect to two courses chosen from Education 301, 302, 303, and 304. Course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education degree. The program that a student proposes to follow must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted as meeting requirements for the Doctor of Education or the Doctor of Philosophy degrees.

Degree of Doctor of Education. Programs leading to the degree of Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

Admission. A candidate for admission must hold a master's degree from an accredited institution. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

Applicants for admission should present credentials well in advance of the date for their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the student is accepted by an adviser.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

Residence. Minimum residence requirements are (a) two consecutive semesters during each of which a minimum of three units of work is successfully completed or (b) one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. A minimum of sixteen units of course work beyond requirements for the master's degree is required. Extramural course work may not be included in this sixteen-unit requirement. A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the degree of Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. A minimum of ten units must be earned in courses taken at Urbana.

Education 410, 415, and 496 are required (note prerequisites).

A preliminary examination must be passed prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his admission before he may enter the preliminary examination. The preliminary examination is given by a committee appointed by the Dean of the Graduate College. Part of this examination may be written. Part of it must be oral.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations.

The thesis required for the degree of Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis titles and the preparation, submission, and publication of theses must be met.

A final oral examination is held at least two weeks prior to the date the degree is conferred. The examination committee is appointed by the Dean of the Graduate College. The final examination is primarily concerned with the thesis, but also extends over the whole field of the candidate's study. It is designed to determine whether or not the candidate has a thorough and mature understanding of the field of education as a whole.

Degree of Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 227.

GRADUATE STUDY IN SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy degree. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The program of study for school psychologists requires a

minimum of three years of graduate study plus twelve months as an interne. After an applicant is admitted as a graduate student in the department of his choice, his acceptance and his work in this program are subject to review by the Joint Committee on School Psychology, representing the College of Education and the Department of Psychology.

GRADUATE TEACHING FACULTY

Professors: C. M. Allen (Acting Dean of the College of Education), A. W. Anderson, D. P. Ausubel, F. P. Barnes, T. E. Benner, G. M. Blair, H. S. Broudy, R. W. Burnett, L. J. Cronbach, J. J. DeBoer, G. P. Deyoe, R. N. Evans, F. H. Finch, G. C. Finlay, N. L. Gage, J. J. Gallagher, C. R. Griffith, H. M. Hamlin, H. C. Hand, J. T. Hastings, K. B. Henderson, R. S. Jones, M. R. Karnes, W. V. Kaulfers, G. C. Kettelkamp, S. A. Kirk, C. G. Knapp, J. E. McGill, W. P. McLure, P. V. Miller, W. J. Moore, T. E. Newland, M. M. Ohlsen, L. J. Phipps, R. E. Pingry, E. F. Potthoff, C. W. Sanford, H. A. Schultz, J. H. Shores, R. H. Simpson, B. O. Smith, W. O. Stanley, Celia B. Stendler, M. R. Sumption, Letitia Walsh.

Associate Professors: J. M. Atkin, G. J. Froehlich, H. Goldstein, N. E. Gronlund, D. M. Jackson, C. E. Johnson, H. F. Kaiser, F. McMurray, L. E. Metcalf, C. H. Patterson, F. C. Proff, P. J. Runkel, J. R. Suchman, R. A. Tinkham.

COURSES FOR GRADUATES

400. **Problems of Educational Theory.** Analysis of the kinds of problems encountered in constructing an educational theory, and of relations between educational theory and other disciplines, especially philosophy and the social sciences. I; 1 unit. Prerequisite: Education 301. McMurray.

401. **Modern Theories of Education.** A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. II; 1 unit. Stanley.

402. **Educational Movements in the Twentieth Century.** An historical study of significant educational trends during the past sixty years, with special reference to their influence on American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and of efforts to solve the problems since 1900. I; 1 unit. Prerequisite: Education 300, or 302, or 403, or consent of instructor. Anderson.

403. **The Historical Foundations of American Educational Thought.** A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. II; 1 unit. Prerequisite: Education 300 or 302, or consent of instructor. Anderson.

404. **Seminar in Educational Classics.** Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. II; 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. Broudy.

406. **Seminar in the History of Education.** Intensive group study of a small number of selected problems to assist individual students to develop understanding of and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. ANDERSON.

407. **Logical Foundations of Methods.** A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment, and knowing, examined from the standpoint of recent developments in pragmatism. II; 1 unit. Prerequisite: Consent of instructor. MCMURRAY.

408. **Advanced Philosophy of Education.** An examination of philosophical concepts and issues most closely related to problems in education. Includes readings in the major philosophical writings of John Dewey as well as in other writings representing the more significant current philosophical viewpoints opposed to Dewey's outlook. I; 1 unit. Prerequisite: Advanced graduate standing; consent of instructor. BROUDY, STANLEY.

409. **Advanced Philosophy of Education.** Continuation of Education 408. II; 1 unit. Prerequisite: Education 408. BROUDY, STANLEY.

410. **Seminar in Theories of Educational and Social Change.** Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. I, II; 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in Education. BROUDY, SMITH, STANLEY.

411. **Psychology of Adolescence for Teachers.** The psychological significance of adolescence, its biological and social foundation, and its implications for education. I, II; 1 unit. Prerequisite: Education 311 and 312. AUSUBEL, BLAIR.

412. **Advanced Child Development for Students of Education.** A consideration of the nature of the child and his development during the pre-school and elementary school years, with emphasis on development as a process of social learning; and interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. I, II; 1 unit. Prerequisite: Education 311 and 312. AUSUBEL, STENDLER.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. II; 1 unit. Prerequisite: Education 311 and 312. GAGE, SIMPSON.

414. **The Psychology of College Teaching.** Designed particularly for graduate students minoring in education or preparing for college teaching. Psychoeducational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction, analysis

and use of test results and resource materials in this field. I; 1 unit. Prerequisite: A course in psychology; consent of instructor. SIMPSON.

415. **Psychological Theories Applied to Education.** An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. I, II; 1 unit. Prerequisite: Education 311 and 312; Education 411 or 412; candidacy for Ed.D. or Ph.D. in Education. BLAIR.

416. **Problems in Mental Deficiency.** An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis; social, medical, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, anthropology, and psychology to educational theory and practice with reference to the mentally deficient. I; 1 unit. Prerequisite: Education 322 or 323, or consent of instructor. KIRK.

417. **Psycho-educational Problems of Exceptional Children.** A course for teachers, elementary school supervisors, principals, and superintendents, and for supervisors of special education programs. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children, consideration of the special school provisions needed for their education and development, including the social and educational backgrounds of special education programs, the problems of selection of children for special education, teaching procedures, buildings and equipment needed in the programs, legal bases for such programs, financing, and administration. I, II; 1 unit. Prerequisite: Sixteen hours of psychology and/or education, or consent of instructor. KIRK, NEWLAND.

418. **Problems in Communication for the Deaf.** An advanced course in the problems of communications used by the deaf, including the learning of language, reading, speech, and speech reading. Consideration is given to the various methods that are used in the teaching of these basic skills to deaf children and the psychological principles underlying the methods. A critical analysis is made of each topic considered. II; 1 unit. Prerequisite: Education 319 and 320, or equivalent.

419. **Clinical Educational Diagnosis.** A clinical course in the diagnosis of educational disabilities, including reading, spelling, and arithmetic. Practice in the use of diagnostic instruments, interpretation of results, and case studies, with recommended remediation, are emphasized. II; 1 unit. Prerequisite: Education 311 and 312; Psychology 443. KIRK.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, and of the somatopsychological significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed on different groups of handicapped children and adults by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. The implications of somatopsychological findings and theories for current educational programs for the handicapped are analyzed. II; 1 unit. Prerequisite: Education 117 and 312, or consent of instructor. NEWLAND.

422. **Basic Principles of Counseling.** Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. I, II; 1 unit. Prerequisite: Education 311 and 312. PROFF.

423. **The Use of Tests in Guidance.** Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and

the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. II; 1 unit. Prerequisite: Education 392. HASTINGS, PROFF.

424. **Case Analysis in Guidance.** The nature, synthesis, and use of case data for guidance purposes. Students develop skills in solving typical counseling problems through role playing and other laboratory experiences. II; 2 units. Prerequisite: Education 422 and 423; consent of instructor. PROFF.

425. **Principles of Guidance.** For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. Students who have taken Education 325 are not allowed credit for Education 425. I, II; 1 unit. OHLSEN, PROFF.

426. **Diagnostic and Remedial Programs of the School.** A study of remedial programs in reading, spelling, English, arithmetic, handwriting, and content subjects. I, II; 1 unit. WHITNEY.

427. **Principles and Techniques of Group Guidance.** A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. II; 1 unit. Prerequisite: Education 311, 312, 422, 423, and either 325 or 425; or consent of instructor. OHLSEN.

428. **The Analysis and Use of Occupational Information in Guidance Programs.** Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. I; 1 unit. Prerequisite: Education 325 or 425, or consent of instructor. OHLSEN, SHOEMAKER.

429. **Field Instruction in Counseling.** Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. I, II; 1 or 2 units. Prerequisite: Education 422 and 424 (with consent of instructor, registration in Education 424 may be concurrent). FINCH, OHLSEN, PATTERSON, PROFF.

430. **Elementary School Organization and Administration.** Intended primarily for elementary school principals and for those who are preparing for the principalship. Such topics as the following are considered: present status of the elementary school principal; classification and promotion of pupils; school records; report cards; plans for student participation in self-government; school-community relationships. II; 1 unit. Prerequisite: Education 431 and 439. BARNES, MILLER.

431. **Elementary School Classroom Programs.** An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. I, II; 1 unit. MOORE, STENDLER.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered in the fields of reading and the language arts, social studies, elementary science, and arithmetic. I, II; 1 unit. Prerequisite: Education 431; for the section in reading and the language arts, Education 336, or a course in the teaching of reading or language arts, or consent of instructor; for the section in elementary science, Education 335 and two years of college science, or consent of instructor. ATKIN, JOHNSON, MOORE, SHORES.

434. **Programs in Early Childhood Education.** An advanced course intended primarily for teachers and supervisors of younger children, ages three to eight. Presents a review and analysis of research findings, experimentation, and current trends in curriculum organization, procedures, and materials essential to developing classroom programs for children. S; 1 unit. Prerequisite: Education 431. McGill.

437. **Methods of Child Study.** A study of ways in which teachers can evaluate child behavior and development. Particular emphasis is placed on classroom application. Instruction and practice in the use and interpretation of observations, anecdote records, rating scales, interviews, achievement tests, intelligence tests, questionnaires, sociometric and projective techniques. II; 1 unit. Prerequisite: Education 312 or consent of instructor.

438. **Supervision of the Elementary School.** Designed for present and prospective supervisors in elementary schools. Considers the purposes of supervision in the context of a democratic theory of learning and teaching. The use of teachers' meetings and of individual supervisory techniques are given special attention. I; 1 unit. Prerequisite: Education 431 and 439. Barnes.

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. I, II; 1 unit. Hand, Shores.

440. **Administration and Supervision of Junior and Senior High Schools.** Discussion of practical problems; functions of the principal; teacher participation; personnel records, marks, failures, and promotions; administration and supervision of the curriculum, of guidance programs, of extracurricular activities, and of housing and building programs. I, II; 1 unit. Prerequisite: Education 460 or consent of instructor. Allen.

441. **Theory and Practice of Teaching in the Secondary School.** An analysis of teaching from the standpoint of social, psychological, linguistic, and logical factors involved in the teaching of content subjects. Recent developments in linguistic analysis, philosophical analysis, and in the psychology of perception are applied to selected problems of secondary school teaching. Lectures and discussion supplemented by observation of classroom activities. II; 1 unit. Prerequisite: Education 301, 311, and 312. Henderson, Smith.

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. II; 1 unit.

447. **Seminar in Rehabilitation Counseling.** Problems of rehabilitation, including problems associated with specific physical and mental disabilities. Critical examination of literature pertaining to rehabilitation, with emphasis on recent publications. May be repeated for a maximum of one unit. I, II; ½ unit. Prerequisite: Education 326 and 442. Patterson.

448. **Adult Education.** Development and status of adult education; discovering needs for adult education; policies, organization, administration, finance; planning programs and courses; methods and materials; the literature of adult education; research in adult education. Systematic study of individual problems supplements class work. II; 1 unit. Hamlin.

449. **Independent Study.** To offer opportunity and challenge of self-directive,

independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. I, II; ½ to 1 unit. No more than two units in Education 449 may be offered toward an advanced degree except by special consent of the Dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. II; 1 unit. WALSH.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. I; 1 unit. WALSH.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. II; 1 unit. WALSH.

455. **Theories of Art Education.** A study of the major theories of art education and an analysis of the most significant research in the field. Emphasis is given to a critical evaluation of theory and research and to the application of such studies to current problems in art education in the public schools. S; 1 unit. Prerequisite: Education 337 or 456, or consent of instructor. LANSING, SCHULTZ.

456. **Curriculum Problems and Trends in Specialized Fields of Secondary Education.** Sections are usually offered in the fields of art education, business education, English, home economics, mathematics, foreign languages, science, social studies, common learnings. Designed to develop an understanding of the function of a specific field of special interest in general education. Applies principles of curriculum construction to the special field. Introduces the student to significant problems, points of view, and trends in the field concerned. Acquaints him with significant research relating to organization, content, and techniques in the fields in question. Students are limited to registration in any two sections in addition to the section on common learnings. I, II; 1 unit. Prerequisite: Education 439. BURNETT, DEBOER, HAND, HENDERSON, KAULFERS, KNAPP, METCALF, SCHULTZ, WALSH.

458. **Foundations of Aesthetic Education.** A philosophical approach to the problems of teaching for appreciation in formal education. Appraisal of the status of aesthetic education, its nature and function, and its relation to other types of education are the major areas to be investigated. Prerequisite: Consent of instructor. I; 1 unit. BROUDY.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of business, English, home economics, physical education, mathematics, science, social studies, and common learnings education. Broader areas of emphasis, within which students may work, are extra-class activities, conservation, consumer education, family living, guidance, health, inter-group relations, labor-management relations, and public opinion and propaganda. S; 1 to 2 units. STAFF.

460. **Public Control and Administration of Education.** A course to provide the basic common understanding of theory and practice in operation and control of schools useful to teachers and other citizens. The course serves as an introductory course for prospective administrative officers and supervisors. Not open to experienced administrators nor to any students who have

taken any of the following courses (or equivalents): Education 430, 440, 461, 462, 464, 465, 466. I, II; 1 unit. BENNER, MILLER, ODELL.

464. **Current Problems in School Administration.** Designed to give direct help on local problems, to serve as a refresher course, and to bring the administrator up to date on recent developments in school administration. Open only to students currently employed as school administrators. S; 1 to 2 units. STAFF.

465. **Public School Finance and Business Administration.** The theory and practice of financing public education in the United States; development of guiding principles in educational finance, trends and needs in state and federal participation in school support, and local operational finance. Not open to students who have completed Education 461 or 462. II; 1 unit. Prerequisite: Education 460. MCLURE, MILLER.

467. **The American College.** Development of the American college and university, public and private; conflicting theories; present trends. II; 1 unit. BENNER.

468. **Public Relations of the Schools.** Study of the interrelationships between the lay community and the schools. Appraisal of procedures, actual or proposed, for the improvement of these relationships. I, II; 1 unit. BENNER.

469. **Legal Basis of School Administration.** The legal rights, privileges, responsibilities, immunities, and authority of pupils, parents, teachers, administrators, and school board members in relation to the school. I; 1 unit. SUMPTION.

471. **Policy and Policy Making for Public School Education in Agriculture.** Local, state, and national policies for agricultural education in the public schools; organizing and conducting policy making; desirable policies. Open to school administrators as well as teachers of agriculture. I; ½ unit. Prerequisite: Agricultural Education 276 and 277. Open to school administrators without prerequisite. HAMLIN.

472. **Course Planning and Teaching Procedures in Vocational Agriculture.** Gathering data essential in course planning, constructing course plans, developing resource units, teaching procedures and instructional aids. I; ½ unit. Prerequisite: Agricultural Education 276 and 277. DEYOE.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, adult education in the public schools, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. II; ½ unit. Prerequisite: Agricultural Education 276 and 277. HAMLIN.

474. **Supervised Farming in Vocational Agriculture.** Importance and meaning of supervised farming; evaluation of supervised farming; relation to establishment in farming; selecting and planning farming programs; records; related instruction; supervision; nature of supervised farming for students in day-school, young farmers, and adult farmers classes. I, II; ½ unit. Prerequisite: Agricultural Education 276 and 277. DEYOE.

475. **Organizing and Teaching Farm Mechanics.** Farm mechanics as a phase of vocational education in agriculture; purposes, course planning for high school students, young farmers, and adult farmers, methods of teaching and evaluating, on-farm instruction, planning farm mechanics shops and facilities, providing and teaching safety in farm mechanics. S; ½ unit. Prerequisite: Agricultural Education 276 and 277. PHIPPS.

476. **Guidance in Agricultural Education.** The guidance function in high school, young farmers and adult farmers classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation

of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment in farming, placement, follow-up. S; ½ unit. Prerequisite: Agricultural Education 276 and 277. KREBS.

477. **Field Studies in Agricultural Education.** For experienced teachers of agriculture. Study of policies, programs, and practices in the schools in which the students are employed; planning and introducing new policies, programs, and practices. I (offered extramurally only); ½ unit. Prerequisite: Agricultural Education 276 and 277. Available only to persons employed in Illinois. DEYOE, HAMLIN.

481. **History and Basic Concepts of Vocational Education.** A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. I; 1 unit. KARNES.

482. **Research Studies in Industrial Education.** Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student proposes and completes a brief research, or plans in detail a major research project to be completed later. II; 1 unit. EVANS, KARNES.

487. **Seminar in Industrial Education.** I; 1 unit. EVANS.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses. Study of basic concepts underlying course construction in industrial education. II; 1 unit. Prerequisite: Undergraduate work in industrial education. EVANS, KARNES.

489. **Administration and Supervision of Industrial Education.** Problems and approved practices in the administration and supervision of programs of industrial education in the secondary schools. I; 1 unit. Prerequisite: Undergraduate work in industrial education. KARNES.

490. **Seminar for Advanced Students of Education.** Open only to persons who have been admitted to candidacy for the degrees of Doctor of Philosophy or Doctor of Education. Sections of this seminar are usually offered in the following areas: philosophical and social foundations of education, psychological foundations of education, elementary education, secondary education, educational administration, guidance and counseling, education of the exceptional child, industrial arts and vocational education, agricultural education, and home economics education. I, II; 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the degree of Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation; tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. I, II; 1 to 2 units. STAFF.

495. **Theory of Measurement.** Same as Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. I; 1 unit. Prerequisite: Education 496 or Psychology 407; Education 392 or Psychology 290, or equivalent. CRONBACH, HASTINGS, KAISER.

496. **Statistical Methods in Education.** First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and

the testing of statistical hypotheses; and other applications of statistics to educational research. I; 1 unit. Prerequisite: Education 390. GAGE, PINGRY.

497. **Advanced Statistical Methods in Education.** An advanced course in statistical methods applied to educational research. Statistical estimation, analysis of variance and co-variance, statistical design of experiments, introduction to factor analysis, the use of mathematical models in educational theory. II; 1 unit. Prerequisite: Education 496.

498. **Theory of Educational Evaluation.** Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. II; 1 unit. Prerequisite: Education 496. HASTINGS.

499. **Thesis Research.** Individual direction of research and thesis writing. I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **The History of Education.** Brief, introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. I, II; ½ unit. ANDERSON.

301. **Philosophy of Education.** Based on Dewey's *Democracy and Education,* this course is an examination of experimentalist philosophy in its bearings on educational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. I, II; ½ unit. MCMURRAY.

302. **History of American Education.** The development of American education in relation to political, social, and cultural developments. Special attention is given to the influence of movements in the cultural environment upon evolving conceptions of educational theory and practice. I, II; ½ unit. ANDERSON.

303. **Comparative Education.** A study of selected national systems of education in their differing cultural settings. I, II; ½ unit. BENNER, KAULFERS.

304. **Social Foundations of Education.** An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. I, II; ½ unit. SMITH, STANLEY.

311. **Psychology of Learning for Teachers.** A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understandings. I, II; ½ unit. Prerequisite: Education 211; practice teaching or teaching experience. BLAIR, CRONBACH, GRIFFITH, GRONLUND, JONES, POTTHOFF, SIMPSON.

312. **Mental Hygiene and the School.** An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. I, II; ½ unit. Prerequisite: Education 211; practice teaching or teaching experience. BLAIR, GRIFFITH, GRONLUND, JONES, POTTHOFF, SIMPSON.

315. **Sociology of Education.** Same as Sociology 315. Objective comparative

study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. I, II; ½ to 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. SHIDELER.

316. **The Gifted Child in School and Society.** A consideration of the gifted in society: who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the consideration and evaluation of instructional and administrative adjustments that should be made for the gifted in the educational structure. I; ½ to 1 unit. Prerequisite: Psychology 100. NEWLAND.

318. **Workshop and Laboratory in Education of Exceptional Children.** Observation of special laboratory classes of various types of exceptional children; group discussions; conferences with specialists as consultants; work on a project of particular concern to the individual student. S; 1 unit for four weeks; 2 units for eight weeks. GOLDSTEIN.

319. **Special Education of the Deaf.** Survey of the curriculum and techniques in pre-schools, kindergarten, and primary and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child. A study of sense training, lip reading, vocabulary development, reading techniques, language and speech development, auditory training, and curriculum construction. I; 1 to 1½ units. Prerequisite: First three years of curriculum for teachers of the deaf, or equivalent.

320. **Special Education of the Deaf.** Continuation of Education 319. II; 1 to 2 units. Prerequisite: Education 319.

321. **Care and Education of Orthopedically Handicapped Children.** Survey of orthopedic handicaps in children, psychological and social effects of such handicaps, and the kinds of schools and services provided for the education of the various types of crippled children. The education of the cerebral palsied child is emphasized. S; 1 unit. Prerequisite: A teacher's certificate or a major in some area of special education.

322. **Psychology and Education of the Mentally Handicapped.** A study of the social, emotional, physical, and learning characteristics of mentally handicapped children; methods of diagnosis and differentiation; educational organization and teaching techniques employed for their rehabilitation. I; ½ unit. Prerequisite: Education 231. GOLDSTEIN, KIRK.

323. **Psychology and Education of the Mentally Handicapped.** Continuation of Education 322, with emphasis on curriculum. II; ½ unit. Prerequisite: Education 322. GOLDSTEIN, KIRK.

324. **Mental and Educational Measurement of Exceptional Children.** Designed primarily to develop an understanding of and ability to interpret the results of psychological and educational tests. Some practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing children who are acoustically, orthopedically, visually, or mentally handicapped, or speech defective. II; ½ to 1 unit. Prerequisite: Education 117 or consent of instructor. KIRK, NEWLAND.

325. **Introduction to Guidance and Counseling.** Basic concepts and practices of guidance in schools; what the teacher can do in guidance. Students may not register for credit in both Education 325 and 425. I, II; ½ unit. Prerequisite: Eight semester hours in education and psychology. OHLSEN.

326. **Introduction to Vocational Rehabilitation Counseling.** A survey of the history and development of vocational rehabilitation programs; contributions of related disciplines and their integration; basic procedures and

problems of vocational rehabilitation counseling. I; ½ unit. Prerequisite: Consent of instructor. PATTERSON.

335. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the classroom teacher, and the specialist. Opportunity for experience in field and laboratory work. I, II; ½ unit. Prerequisite: Education 101 and 201 or equivalent; two years of college science. ATKIN, BURNETT.

336. **Primary Reading.** Critical evaluation of current schools of thought with regard to the teaching of reading and an analysis of the concept of learning as well as the meaning of reading upon which each school is based. Attention is given to reading as a part of the total growth process of the child and to knowledge of methods and materials used in teaching beginning reading. I, II; ½ unit. Prerequisite: Education 101, 201, and 230. MOORE, STENDLER.

337. **Art Education in the Elementary School.** Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. I, II; ½ unit. Prerequisite: Education 101, 201, and 230. SCHULTZ.

338. **Supervision of Art in the Public Schools.** A study of supervisory and administrative problems encountered in elementary and secondary school art programs. II; ½ unit. Prerequisite: Education 337 or consent of instructor.

354. **Audio-Visual Materials and Problems.** Audio-visual materials are examined from the point of view of their effectiveness and possible utilization in the school program. Recent investigations on materials and methods of presentation are studied to ascertain their pedagogical implications. The technical and administrative problems of integrating audio-visuals into the school curriculum are considered. S; ½ unit. Prerequisite: Education 211, 231, or 241. PETERSON.

370. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meeting in August. Other meetings in centers in the state convenient to first-year teachers. Visits by instructor to schools in which the students are employed. I, II; ½ unit. Prerequisite: Agricultural Education 276 and 277. KREBS, PHIPPS.

381. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. I; ½ to 1 unit. EVANS, KARNES.

382. **Organization and Administration of Diversified Occupations Programs.** Designed to provide the specific professional training required of teachers and coordinators who are to conduct programs of diversified occupations in the secondary schools. II; ½ to 1 unit. KARNES.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. II; ½ to 1 unit. EVANS, KARNES.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. S; 1 unit. Prerequisite: Sixteen hours in industrial education. LUX, TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, together with their relationships to other educational agencies. II; 1 unit. EVANS.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of

the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. I, II; 1 unit. Prerequisite: Ten hours of undergraduate credit in industrial education. EVANS, KARNES.

390. **Elements of Educational Statistics.** Designed for terminal value for professional training of students not intending to pursue advanced graduate work, and for introductory value for students continuing graduate study in education. Includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. I, II; 1 unit.

391. **Construction and Use of Tests in Teaching.** Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking procedure. Designed primarily for classroom teachers. I; ½ to 1 unit. Prerequisite: Education 211.

392. **Introduction to the Principles of Measurement.** Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. II; ½ to 1 unit. Prerequisite: Education 211. CRONBACH, GAGE.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the degree of Master of Science in Electrical Engineering and Doctor of Philosophy in Engineering is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois in the option in which advanced work is desired. The fields of specialization are physical electronics and electronic engineering, communication engineering, and power engineering. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. An applicant's undergraduate grade-point average must be at least 3.75.

Courses for advanced undergraduates and graduates are also open for credit to students with majors in other departments who have the proper prerequisites.

The objectives of a well-rounded graduate program in electrical engineering may be classified as follows:

(1) Development of a more thorough understanding of the basic fundamentals of electrical engineering.

(2) Development of better tools for the solution of electrical engineering problems.

(3) Uncovering of special characteristics of initiative and resourcefulness.

(4) Development of a specialist's understanding in some area of the electrical engineering field.

An advisory committee of graduate faculty members is appointed for each graduate student who completes the first year of graduate work. This committee and the student work out the graduate study program to be followed. A qualifying examination is ordinarily held in the fall and spring of each year for graduate students who have received the Master of Science degree. The results of this examination are available to the advisory committee as an aid in counseling.

Students in all areas of electrical engineering are required to complete satisfactorily at least one graduate (400) course in the general area of circuits and at least one graduate (400) course in field theory for the Master of Science degree. Students who already have the master's degree must furnish evidence of equivalent training or enroll in such courses in the first year of residence. Candidates for the Master of Science degree are also required to have credit in at least one course in modern physics. However, graduate students who present satisfactory undergraduate credit in modern physics are considered to have completed this requirement. Candidates for the Doctor of Philosophy degree are required to complete at least two courses in modern physics. It is also expected that the student enroll in such additional mathematics work as a review of his training and the field in which he specialized would indicate advisable. Advanced courses in mathematics, physics, chemistry, mechanics, and in other branches of engineering are suggested as suitable minor subjects. A minor sequence in physics to include Physics 381 and 362 is recommended. It is strongly recommended that students who are candidates for the Master of Science degree and expect to continue graduate work elect to write a thesis.

GRADUATE TEACHING FACULTY

Professors: E. C. Jordan (Head of Department), G. E. Anner, L. B. Archer, D. S. Babb, A. D. Bailey, J. Bardeen, W. H. Bruckner, P. D. Coleman, G. A. Deschamps, W. L. Emery, W. L. Everitt, M. A. Faucett, G. H. Fett, W. J. Fry, L. Goldstein, H. N. Hayward, M. S. Helm, C. A. Keener, W. E. Miller, G. R. Peirce, J. E. Robertson, J. P. Ruina, C. E. Skroder, G. W. Swenson, Jr., M. E. Van Valkenburg, H. M. Von Foerster, N. Wax, H. D. Webb, J. E. Williams.

Associate Professors: W. G. Albright, J. H. Cahn, M. H. Crothers, A. A. Dougal, P. R. Egbert, E. W. Ernst, E. C. Hayden, C. D. Hendricks, D. F. Holshouser, P. Mast, P. E. Mayes, M. S. McVay, D. E. Muller, T. A. Murrell, J. P. Neal, P. F. Schwarzlose.

Assistant Professors: F. Dunn, F. J. Fry, S. L. Hakimi, P. Handler, J. O. Kopplin, B. C. Kuo, Y. T. Lo, R. Mittra.

COURSES FOR GRADUATES

400. **Seminar.** Required of all graduate students. I, II; no credit. Jordan.

410. **Engineering Analysis.** Static and dynamic field problems with emphasis on the relationships between the various branches of engineering and the development of the use of mathematics as a tool in the solution of complex problems. I, II; 1 unit. Bailey.

412. **Advanced Engineering Measurements.** Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. I, II; 1 unit. Hayward, Peirce.

413. **Servomechanisms and Automatic Control Devices.** Fundamental theory of servomechanisms and other automatic control devices, electrical analogies, stability, transfer functions, and on-off mechanisms. I, II; 1 unit. Fett.

414. **Foundations of Electrical Network Theory, I.** Formulation and study of foundation axioms of electrical networks, topological basis of mesh and node methods, mesh and node equations by means of matrix transformations, and general proofs of standard network theorems. I, II; 1 unit.

416. **Advanced Circuit Analysis.** Fundamentals of network theory and theorems, transients, Laplace transform, and the complex frequency concept. I, II; 1 unit. McVay, Van Valkenburg.

418. **Electric and Magnetic Fields.** Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. I, II; 1 unit. Emery.

419. **Dynamic Network Analysis.** Extension of static network theory to networks having relative motion between elements, with particular emphasis on the analysis of rotating electrical apparatus when considered as an integral part of complex control systems. I, II; 1 unit. Prerequisite: Electrical Engineering 416.

420. **Electromagnetic Waves and Radiating Systems.** Fundamental electromagnetic theory with applications to transmission lines, wave guides, and antennas. I, II; 1 unit. Jordan, Mayes.

421. **Advanced Electromagnetic Engineering.** Huyghen's principle; uniqueness and reciprocity theorems; Babinet's principle; reaction concept; variational methods; applications to plane, cylindrical, and spherical wave problems. Application to a general method of calculating the result of any practical measurement such as antenna radiation pattern and impedance, the parameters of wave guides and cavities, and observations on scattering and diffraction. I, II; 1 unit. Prerequisite: Electrical Engineering 420. Deschamps.

422. **Advanced Communication Networks.** Fourier integral and matrix algebra, analysis of networks, and network synthesis for wide band operation. I, II; 1 unit. Skroder.

423. **Electron and Ion Dynamics.** Laplace equation, conformal transformations, Poisson's equation with initial velocities and transit time, electron optics, and electron ballistics of klystrons and magnetrons. I, II; 1 unit. Prerequisite: Credit or registration in Electrical Engineering 420. Dougal, Wax.

424. **Theory of Gaseous Discharge Devices.** Motion of ions and electrons; ionization and deionization; space charge and plasma; glow and arc discharges; circuit interruption; arc extinction problems. I, II; 1 unit. Goldstein.

426. **Electroacoustical Systems.** A study of the solutions of differential equations of wave motion with applications to vibrating strings, membranes, rods, sonic systems, loud speakers, microphones, galvanometers. I, II; 1 unit. Fry, Swenson.

427. **Boundary Value Problems.** Derivation and solution of partial differential equations and integral equations of mechanics and electricity and magnetism; study of the analysis of wave motions. I, II; 1 unit. Coleman.

428. **Nonlinear Oscillating Systems.** Criteria for stability of nonlinear oscillations; nonlinear resonance; study of analytical methods; harmonics and subharmonics, and relaxation oscillations. I, II; 1 unit. Fett.

429. **Vacuum Tube Circuit Analysis.** Vacuum tube network theory, feedback circuits and amplifiers, stability, equalizers, and relations between components of network functions. I, II; 1 unit. Crothers, Fett.

430. **Gas Tube Circuit Analysis.** Equivalent circuit of gas tubes at low and high frequencies, circuit analysis, and rectifiers. II; 1 unit.

431. **Microwave Circuits.** Four-terminal networks and transmission line theory, bilinear transformations, wave guides, the generalized impedance concept, expansion of fields in normal modes, resonant cavities, and measurement techniques. I, II; 1 unit. Prerequisite: Electrical Engineering 420. Emery, Mittra.

433. **Transmission of Information.** II; 1 unit. Ruina, Wax.

435. **Conduction of Electricity in Solids.** Same as Physics 435. Application o quantum principles to conduction of electricity in solids, impurity and in trinsic semiconductors, Hall and thermoelectric effects, photoconductivity p-n junctions, and rectifying contacts, theory and characteristics of transis tors. II; 1 unit. Prerequisite: Physics 381 or consent of instructor. BARDEEN

436. **Applied Electrodynamics.** Tensor form of Maxwell's equations, special rela tivity, radiation reaction, integration of wave equations. Fourier analysis o radiation fields, Lagrange and Hamiltonian equations. Applications to sub millimeter wave generation, Cerenkov effect, radiation from particle accelera tors, electron bunching at high energies. II; 1 unit. Prerequisite: Electrica Engineering 420 and 423. COLEMAN.

440. **Advanced Power Circuit Analysis, I.** Analysis of power systems by symmetrical and related components; equivalent circuits of lines, transformers and machines; fault calculations on symmetrical and unsymmetrical power systems; the network analyzer in fault studies. I, II; 1 unit. HELM.

441. **Advanced Power Circuit Analysis, II.** Advanced topics in the analysis of power systems by symmetrical and related components; simultaneous faults on symmetrical power systems; impedances of unsymmetrical transmission lines; capacitances of unsymmetrical transmission lines. I, II; 1 unit. Prerequisite: Electrical Engineering 440. HELM.

442. **Advanced Analysis of Alternating Current Machinery.** Steady state analysis of synchronous machines, round rotor and salient poles, magneto-motive forces with symmetrical and unsymmetrical windings, torque angle characteristics, vibration, and noise. I, II; 1 unit. KEENER.

443. **Analysis of Dynamo Machines Under Transient Conditions.** Analysis of the operation of alternating and direct current machines under transient conditions, armature and field phenomena and mutual reactions of dynamo machines with system transients. I, II; 1 unit. Prerequisite: Electrical Engineering 442. KEENER.

444. **Advanced Power System Analysis.** Electrical and mechanical properties of transmission systems, calculations of fault currents, power diagrams, and power limits. I, II; 1 unit. Prerequisite: Electrical Engineering 440. FAUCETT.

445. **Power System Stability.** Transient and steady-state stability in power systems; power flow equations; transient stability swing curves; critical clearing times; the network analyzer in stability studies; the analog computer in transient stability studies. I, II; 1 unit. Prerequisite: Electrical Engineering 440 or 444. FAUCETT, HELM.

446. **Electrical Design (Apparatus).** Properties of materials, field mapping, leakage fields, cooling and rating of apparatus, limitations affecting design, prediction of operating characteristics, and special design problems. I, II; 1 unit. ARCHER.

447. **Electrical Design (Power System).** Sources of energy, location of generating stations, selection of units, location of transmission lines, layouts of systems, and extension of established systems. I, II; 1 unit. FAUCETT.

451. **Network Synthesis.** A study of methods for the synthesis of networks for prescribed driving-point or transfer characteristics. I; 1 unit. Prerequisite: Mathematics 345. VAN VALKENBURG.

452. **Network Synthesis.** A continuation of Electrical Engineering 451. II; 1 unit. Prerequisite: Mathematics 345. VAN VALKENBURG.

453. **Automatic Feedback Control System Synthesis.** Synthesis of automatic feedback control systems through pole-zero configurations. II; 1 unit. Prerequisite: Electrical Engineering 413 and 451. VAN VALKENBURG.

197. **Electrical Engineering Problems.** Special electrical engineering problems. I; ½ to 2 units. STAFF.

198. **Electrical Engineering Problems.** Special electrical engineering problems. II; ½ to 2 units. STAFF.

199. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

320. **Introduction to Circuit Analysis.** Study of the formulation and solution of network equations for sinusoidal and general signals, network theorems, three-phase systems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 126; Physics 107; Mathematics 345; credit or registration in Electrical Engineering 321.

321. **Circuit Laboratory.** To accompany Electrical Engineering 320. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 229 and 320.

322. **Circuit Analysis.** Continuation of Electrical Engineering 320. General network analysis, LaPlace transforms, network functions and poles and zeros; LC networks and filters. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 320 and 321; Mathematics 345; credit or registration in Electrical Engineering 323.

323. **Circuits Laboratory.** To accompany Electrical Engineering 322 and 350. I, II; 0 to ¼ unit. Prerequisite: Electrical Engineering 320 and 321; credit or registration in Electrical Engineering 322 and 350.

330. **Theory of Electrical Machinery, I.** Analysis of the electric and magnetic circuits and fields of electrical machinery. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 126 or equivalent; credit or registration in Electrical Engineering 320, 321, and 331.

331. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 330. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 330.

332. **Theory of Electrical Machinery, II.** Analysis of transformer reactors and induction motors, and their single and polyphase characteristics. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 126 or equivalent; Electrical Engineering 320, 321, 330, and 331; credit or registration in Electrical Engineering 322, 323, 332.

333. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 332. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

334. **Electrical Power Apparatus.** Single- and three-phase transformers. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 322 and 323; credit or registration in Electrical Engineering 335.

335. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 334. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 334.

336. **Advanced Analysis of Electric Power Equipment.** Transformers, synchronous and induction machines; power machines in systems; single phase motors; extension of the two reaction analysis to the general machine. I, II; 0 to ¾ unit. Prerequisite: Credit or registration in Electrical Engineering 332 and 333.

337. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 336. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 336.

338. **General Circuit Analysis of Electrical Machinery.** General theory of the ideal machine, voltage and torque equations, direct current machines in control systems; general equations for synchronous and induction machines with simple transients; generalized rotating machine systems with equivalent circuits with various systems of reference. I, II; 0 to ¾ unit. Prerequisite: Credit or registration in Electrical Engineering 332 and 333.

339. **Electrical Power Apparatus Laboratory.** To accompany Electrical Engineering 338. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 338.

340. **Electronics.** Emission, electron ballistics, high vacuum electron tubes, semiconductors and transistors, tube and transistor characteristics and equivalent circuits, gaseous conduction and gas tubes, introduction to methods of analysis. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 320 and 321.

341. **Electronics Laboratory.** To accompany Electrical Engineering 340. I, II; 0 to ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 340.

342. **Advanced Electronics.** Linear and nonlinear amplification; modulation and demodulation concepts; introduction to feedback amplifiers and oscillators. I, II; 0 to ¾ unit. Prerequisite: Electrical Engineering 340 and 341.

343. **Electronics Laboratory.** To accompany Electrical Engineering 342. I, II; 0 to ¼ unit. Prerequisite: Electrical Engineering 340 and 341; credit or registration in Electrical Engineering 342.

347. **Industrial Electronics.** Electronic circuits for automatic control and measurement systems with applications. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322, 332, and 342; Electrical Engineering 381. Credit toward graduation is not given for both Electrical Engineering 347 and 381.

349. **Electron Tube Circuits.** Linear and nonlinear amplifiers, fundamentals of modulation and detection, oscillators, rectifiers. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 342.

353. **Radio Circuits.** Component behavior at communication frequencies, impedance transforming networks for single and multiple frequencies; low-level tuned and compensated amplifiers, broad band impedance matching; equalizers. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 322 and 341.

355. **Fields and Waves.** Theory of UHF and microwave generators; electromagnetic fields, radiation and propagation of electromagnetic energy, radiating systems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 349 and 351.

357. **Radio Astronomy.** Same as Astronomy 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. I or II; 1 unit. Prerequisite: Physics 107 and 108. Swenson, Wyatt.

359. **Introduction to Noise and Information Transmission.** Signals and their spectra; methods of communication systems analysis; modulation by AM, FM, PAM, PPM; origin of noise, properties of noise, introduction to probability theory, system comparison using statistical approach. I, II; ¾ to 1 unit. Prerequisite: Electrical Engineering 322; credit or registration in Electrical Engineering 342.

376. **Symmetrical Component Analysis of Power Systems.** Representation of power systems; symmetrical component, positive negative and zero sequence imped-

ances of network components, sequence networks; unsymmetrical faults, unsymmetrical power systems, matrix algebra in symmetrical component analysis. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

377. **Electric Motor Application and Control.** Determination of torque and power requirements of various motor loads; control of direct current motors, Ward-Leonard system with dynamic exciters; control of induction motors; comparison of various types of motors with factors determining choice. I, II; 0 to ¾ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

378. **Electric Power Networks.** Steady state power network analysis; inductive coordination; transmission line capacitance and resistance; networks synthesis; application of computers to power network problems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

379. **Elements of Power System Stability.** The stability problem, power flow equations, steady state stability limits, transient stability swing equations, point-by-point solution, influence of type of fault on transient stability limit. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

381. **Pulse Techniques.** Response of electrical systems to repeated transients. I, II; 0 to 1 unit.

382. **Transistor Circuits.** Introduction to circuit properties of point-contact and junction transistors and diodes; linear and nonlinear transistor circuits. With laboratory. Credit is not given for both Electrical Engineering 382 and 383. II; 1 unit. Prerequisite: Electrical Engineering 349 or equivalent course in electron tube circuits.

383. **Transistor Circuits.** Introduction to circuit properties of point-contact and junction transistors and diodes; linear and nonlinear transistor circuits. No laboratory. Credit is not given for both Electrical Engineering 382 and 383. II; ¾ unit. Prerequisite: Electrical Engineering 349 or equivalent course in electron tube circuits.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. II; 0 to 1 unit.

387. **Electrical Equipment Synthesis.** Stored energy in fields, force of attraction, construction and analysis of field maps, materials, heat flow and heat dissipation, temperature rise and fall, dimensional analysis and theory of models, analogies for model studies, sources of additional ideas, and specific design problems. I, II; ¾ unit. Prerequisite: Electrical Engineering 332 or equivalent.

388. **Electronic Analog Computers.** Design of analog computer elements, problem preparation, and representative solutions of physical problems. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 341 and Mathematics 345, or consent of instructor.

389. **Communication Design.** Design, construction, and complete test of a radio transmitter or receiver. I, II; 0 to 1 unit. Prerequisite: Electrical Engineering 349 and 353.

391. **Boolean Algebras with Applications to Computer Circuits, I.** Same as Mathematics 391. An introduction to Boolean algebra with a discussion of the elementary applications to set theory, logic, and both relay and electronic switching circuits. The Harvard chart method and other methods for circuit simplification are treated both as applied to single output and multiple output circuits. I, II; ½ to 1 unit. Prerequisite: Senior standing; consent of instructor.

392. **Boolean Algebras with Applications to Computer Circuits, II.** Same as Mathematics 392. The notion of time as a parameter is introduced into the theoretical treatment of switching circuits. Examples of synthesis of time-dependent circuits are given using mathematical techniques. I, II; ½ to 1 unit. Prerequisite: Mathematics 391.

393. **Digital Computer Electronics.** After a brief review of transistor theory and the pulse response of networks, the problems associated with the reliable design of all standard switching circuits under given tolerance conditions are presented. The interrelation of components and systems is shown. Timing problems are discussed in both synchronous and asynchronous machines. I; ¾ to 1 unit. Prerequisite: Electrical Engineering 294 and 341, or consent of instructor.

394. **Logical Design of Automatic Digital Computer Circuits.** A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. I, II; 1 unit. Prerequisite: Electrical Engineering 294 and senior standing, or consent of instructor.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric)

Students who wish to be considered for admission to graduate work in English must have attained a grade-point average of at least 3.75. Students whose averages are between 3.75 and 4.0 must achieve a satisfactory score on either the Graduate Record Examination or the Miller Analogies Test. All students must present the equivalent of at least fourteen hours of undergraduate work in English or American literature, not including required college work in rhetoric. They must also present the equivalent of four semesters of college work in Latin, Greek, French, Russian, or German, or, lacking such credit, make good the deficiency before receiving the master's degree. (Four semesters of college Spanish are accepted only from candidates for the Master of Arts in the Teaching of English, not from candidates for the Master of Arts in English.) Undergraduate work in English would be best distributed in the following way to provide a foundation for graduate work: (1) historical surveys of English and American literature; (2) a course or courses in major writers, e.g., Chaucer, Shakespeare, Milton, Whitman, Melville, etc.; (3) period courses in the Renaissance, seventeenth, eighteenth, nineteenth, or twentieth centuries; (4) courses in literary types, criticism, etc., e.g., the novel, poetry, drama. Students are also urged to offer courses in history and philosophy that are central to an understanding of literature.

Students with undergraduate minors in English may be admitted to graduate courses only with consent of the instructors in charge.

Degree of Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates for the degree of Master of Arts in English are required to choose at least four of their courses from those at the 400 level. They must also give evidence that they have had the equivalent of at least two years of undergraduate work in French or German (Latin or Greek or Russian may be substituted). They may do this (1) by presenting evidence that they have satisfactorily completed two years of undergraduate study in either language, (2) by passing the reading examination for the doctorate in either language, or (3) by taking and passing with a grade of C either French 400 and 401 or German 400 and 401.

Candidates must also pass a qualifying examination. This is a two-hour written examination devised to test the student's knowledge of and interpretative skill in English and American literature. The examination is given during the

rst week of each semester and of the summer session. *It must be taken during he student's first semester of residence.* In the event of failure, the student must ake the examination again as soon as it is offered, provided he is in residence. s a guide to prospective candidates, it is suggested that the following undergrad- ate courses best fit the pattern of the examination: (1) a course in a major riter (e.g., Chaucer, Shakespeare, Milton, or Melville), (2) a course in a period f literature (e.g., the Renaissance or the eighteenth century), (3) a course in a terary type (e.g., drama, satire, or novel), and (4) surveys of English and Ameri- an literature. Preparation for the examination should include a review of the istory of English and American literature emphasizing the major works and major uthors of various periods. Some experience in the critical and interpretative valuation of literature, particularly poetry, is essential.

A master's thesis is not required, although a student may elect to offer one ith the approval of his adviser.

Degree of Master of Arts in the Teaching of English. Candidates for the egree of Master of Arts in the Teaching of English must earn four and one-half nits in English, at least two of them in courses at the 400 level, and they must ake the qualifying examination for master's candidates in English. Those who ail the qualifying examination may substitute two additional units of graduate ork beyond those normally required. Candidates must also give evidence that hey have had the equivalent of at least two years of undergraduate work in rench, German, Latin, Greek, or Spanish.

Specific requirements are divided into two programs, the first for those who ave the A.B. degree in English and the teacher's certificate, and the second for hose who have the A.B. degree in English but not the teacher's certificate.

For those with the certificate, the requirements are English, four and one-half nits, including English 445 and 446 and at least one course above the 450 level; ducation, one and one-half units as follows: one unit in Education 311 and 312, nd one-half unit chosen from Education 301, 302, 303, or 304; specialized courses or high school teachers of English, as follows: one unit of either Education 456 r English 447, one-half to three-quarters unit of either English 387 or Rhetoric 80; electives, one-half to one unit as needed to total eight units.

For those without the certificate, the requirements are English four and one- alf units, including English 445 and 446 and at least one course above the 450 evel; education, two units as follows: one-half unit of Education 311, one-half nit of either Education 312 or 219, one unit from Education 301, 302, 303, or 04; specialized courses for high school teachers of English, one-half to three- uarters unit in either English 387 or Rhetoric 480; electives, one-half to one unit s needed to total eight units. In addition to these courses the candidates must ake, without graduate credit, Education 241 and 242. This program is designed o permit most candidates to complete their work and qualify for a certificate nd master's degree in two semesters and a summer. Those who lack certain rerequisites, such as general psychology, may need a little more time.

The courses in English and the elective must be selected with the approval f the head of the department. The electives may be in English, in education, or, n exceptional cases, in other subjects. Candidates for this degree should consult rofessor J. N. Hook, 203 English Building.

Degree of Doctor of Philosophy in English. In addition to satisfying the gen- ral requirements of the Graduate College, candidates for the degree of Doctor of hilosophy in English must take at least two units of work in the problems ourses — those courses numbered 450 and higher. The department recommends hat all work be taken at the 400 level.

English 445 and 446. All entering graduate students are urged — and those ntending to proceed beyond the master's degree are required — to take English

445 and 446, Introduction to Advanced Graduate Study, during their first two semesters in residence, summer session not included.

Proficiency Examination. Since September, 1958, graduate students entering the doctorate program after taking degrees at other universities are required to take a proficiency examination during their first semester of residence. This requirement is met by satisfactory performance on the master's qualifying examination.

Foreign Languages. Each student must demonstrate proficiency in French and German; but with the approval of the adviser and the head of the department he may petition the Dean of the Graduate College to be allowed to substitute Latin or Greek for one of these languages. Since February, 1958, the language requirement may be satisfied only by a written examination. Students should pass at least one of their language examinations by the end of their first academic "year."

Minor Subjects. Students may offer a double minor, which includes English philology and one other subject, or a sole minor in English philology.

If the student elects the former option, he will take English 401 (Anglo-Saxon), 402 (Beowulf), and 403 (History of the English Language) in satisfaction of the requirements for the first minor. The second minor will consist of at least two units in philosophy, history, or a foreign literature (French, German, Greek, Italian, Latin, Spanish). Under exceptional circumstances the student may be permitted by the head of the department to offer a subject other than one of these for his second minor.

If the student elects the latter option he will take English 401, 402, 403, and two further units chosen from the following groups: English 405 or 408, German 426, or French 475, or French 476.

Philology Examination. Each student must pass a comprehensive examination in English philology at least one term before he takes his preliminary examination. This examination is given in October and April of each year. Graduate students making A's in the three basic philology courses are excused from the comprehensive examination in philology.

Preliminary Examination. This examination is given in October and April of each year. It consists of two parts:

(1) The written examination. Each student takes written examinations in four of the following periods: English literature before 1500, English literature in the sixteenth century, English literature in the seventeenth century, English literature in the eighteenth century, English literature in the nineteenth century, American literature before 1865, American literature after 1865.

These examinations last from three to four hours each and are given on successive days. No student is given an oral examination until he has passed all of his written examinations.

(2) The oral examination. The oral examinations cover (a) the four areas chosen for the written examinations; (b) the sole or second minor; (c) in a less intensive form the remaining areas of English or American literature; (d) the field of the candidate's specialization; and (e) a major work in this field, selected by the Graduate Studies Committee of the department, long enough before the examination to allow time for preparation. The examination questions test the candidate's knowledge of the work itself, of the relationship of the work to its genre and period, and of criticism and scholarship dealing with the work, and the candidate's own critical faculties.

Thesis. The student writes a dissertation under the directions of a graduate professor who also serves as his adviser. The student must submit a statement of his thesis plan, outlining its main topics. The statement is presented to the adviser within a reasonable period — usually six months — after the student passes his

preliminary examination. The thesis, together with an abstract, must be submitted in finished form at least two weeks before the student's final examination.

GRADUATE TEACHING FACULTY

Professors: R. W. Rogers (Head of Department), E. H. Davidson, G. B. Evans, J. T. Flanagan, H. F. Fletcher, R. A. Gettmann, M. S. Goldman, M. T. Herrick, A. Holaday, J. N. Hook, M. Krieger, P. N. Landis, B. A. Milligan, S. Paul, R. A. Pratt, C. W. Roberts, C. H. Shattuck, D. A. Smalley, R. M. Smith.

Associate Professors: B. Harkness, H. W. Wilson.

Assistant Professors: A. L. Altenbernd, R. L. Haig, Jr., G. P. Haskell, F. E. Hodgins, Cornelia P. Kelley, J. F. Lynen, W. H. McBurney, L. A. Muinzer, R. Ornstein, R. H. Paulson, H. F. Robins, R. L. Schneider, A. Scott, G. Scouffas, Mary D. Sleator, J. Stillinger, G. B. Stillwell.

English Literature

COURSES FOR GRADUATES

401. **Old English: Anglo-Saxon.** An introduction to the language before 1000 A.D. I; 1 unit. Muinzer.

402. **Old English: Beowulf.** II; 1 unit. Prerequisite: English 401. Smith.

403. **History of the English Language.** A study of the development of the language from the earliest stages to the present time. I; 1 unit. Smith.

404. **Old English Literature and Its Cultural Background.** An intensive, critical examination of Old English prose and poetry exclusive of Beowulf. The texts studied vary from year to year, but particular attention is given to such important bodies of writing as the Elegies, the *Anglo-Saxon Chronicle,* and the works of Cynewulf, Aelfric, Alfred, and Wulfstan. II; 1 unit. Muinzer.

405. **Middle English.** Introduction to middle English dialects, with special emphasis on the East Midland. II; 1 unit. Offered in 1960-1961 and in alternate years. Smith.

406. **Middle English Literature and Its Cultural Background.** English literature from 1100 to 1500 (excluding Chaucer), with emphasis on chronicle, romance, debate, lyric, and such major poems as *Pearl, Sir Gawain and the Green Knight,* and *Piers Plowman;* historical, social and religious backgrounds. I; 1 unit. Pratt.

407. **Studies in Chaucer and His Times.** A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. I; 1 unit. Pratt, Smith.

408. **Studies in Chaucer and His Times.** Continuation of English 407. II; 1 unit. Pratt, Smith.

411. **Studies in Sixteenth-Century Literature.** I; 1 unit. Milligan.

412. **Studies in Sixteenth-Century Literature.** Continuation of English 411. II; 1 unit. Milligan.

413. **Studies in Shakespeare.** I; 1 unit. Evans.

417. **Studies in Seventeenth-Century Literature.** I; 1 unit. Fletcher.

418. **Studies in Seventeenth-Century Literature.** Continuation of English 417. II; 1 unit. Fletcher.

421. **Studies in Eighteenth-Century Literature.** I; 1 unit. Haig, Rogers.

422. **Studies in Eighteenth-Century Literature.** Continuation of English 421. II; 1 unit. Haig, Rogers.

427. **Studies in the Romantic Movement.** I; 1 unit. GETTMANN.

428. **Studies in the Romantic Movement.** Continuation of English 427. II; 1 unit. GETTMANN.

431. **Studies in Victorian Literature.** I; 1 unit. SMALLEY.

432. **Studies in Victorian Literature.** Continuation of English 431. II; 1 unit. SMALLEY.

433. **Studies in Twentieth-Century English Literature.** A study of the chief intellectual and social movements and the literary developments. I; 1 unit. HARKNESS.

441. **Studies in Literary Theory.** The analysis, in accordance with aesthetic principles, of major documents in the history of poetics in order to formulate the central problems of literary theory and to examine proposed solutions to them. I; 1 unit. KRIEGER.

442. **Studies in Recent Literary Theory.** The analysis of representative critics and critical schools of the twentieth century; similarities and differences between them and older critics in the solutions proposed to the central problems of literary theory. II; 1 unit. KRIEGER.

445. **Introduction to Advanced Graduate Study.** A consideration of the methods of literary scholarship. Required of all candidates for the degree of Doctor of Philosophy in English. I; ¼ unit. DAVIDSON.

446. **Introduction to Advanced Graduate Study.** A consideration of the methods and objectives of literary criticism and the profession of college English teaching. Required of all candidates for the degree of Doctor of Philosophy in English. II; ¼ unit. GETTMANN.

447. **Background Materials for High School Teachers of English.** Investigation of the content that is desirable in high school literature and composition. S; 1 unit. HOOK.

450. **Problems in Bibliographical Method.** Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. I or II; 1 unit. Prerequisite: Consent of instructor. EVANS.

457. **Problems in Medieval Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. I; 1 unit. PRATT.

461. **Problems in Spenser.** A study of special problems relating to the works of Edmund Spenser, his background in England and in Ireland, and the second half of the sixteenth century. I or II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: English 326 or any course in the sixteenth century. SMITH.

462. **Problems in Tudor Drama.** I or II; 1 unit. HOLADAY.

463. **Problems in Shakespeare.** I or II; 1 unit. EVANS.

464. **Problems in Elizabethan Drama.** II; 1 unit. EVANS.

467. **Problems in Milton and His Age.** I; 1 unit. Prerequisite: English 417 and 418; second-year graduate standing. FLETCHER.

468. **Problems in Milton and His Age.** Continuation of English 467. II; 1 unit. Prerequisite: English 417 and 418; second-year graduate standing. FLETCHER.

472. **Problems in the Eighteenth-Century Novel.** I or II; 1 unit. MCBURNEY, ROGERS.

475. **Problems in the Theory of Criticism.** An advanced course devoted to the investigation of special theoretical problems underlying the practice of literary criticism. Prerequisite: English 442 or consent of instructor. II; 1 unit. KRIEGER.

477. **Problems in Prose Fiction.** I; 1 unit. Prerequisite: Second-year graduate standing. GETTMANN.

478. **Problems in Prose Fiction.** Continuation of English 477. II; 1 unit. Prerequisite: Second-year graduate standing. GETTMANN.

479. **Problems in Victorian Literature.** Problems in Victorian literature. Prerequisite: English 431 or 432, or consent of instructor. II; 1 unit. SMALLEY.

484. **Problems in Twentieth-Century English Literature.** I, II; 1 unit. Prerequisite: English 433 or consent of instructor. HARKNESS.

497. **Independent Reading.** A course in individual readings from the areas of literature as offered by the department at the advanced undergraduate-graduate level. May only be taken concurrently with a 300-level course. No student may offer more than a total of ½ unit of English 497. Prerequisite: Consent of instructor of requisite 300-level course. I, II; ¼ unit.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. I, II; 0 to 4 units. EVANS, FLETCHER, GETTMANN, GOLDMAN, HAIG, HARKNESS, HERRICK, HOLADAY, HOOK, KRIEGER, LANDIS, MCBURNEY, MILLIGAN, MUINZER, ORNSTEIN, PAULSON, PRATT, ROBERTS, ROBINS, ROGERS, SCHNEIDER, SHATTUCK, SMALLEY, SMITH, STILLINGER, STILLWELL, WILSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Professional Expression.** Same as General Engineering 304. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. I, II; 1 unit. Prerequisite: Senior standing or consent of instructor. MCCLINTOCK.

311. **Chaucer.** I; ¾ unit. STILLWELL.

320. **Arthurian Romances.** The origin and growth of the early legends and their later development in English from Malory to Tennyson and Robinson. I or II; ¾ unit. SMITH.

325. **English Literature from 1588 to 1660.** A survey of English literature during the Renaissance. Sidney, Marlowe, Donne, Jonson, Herrick, Bacon, Burton, and other writers. II; ¾ unit. MILLIGAN.

326. **Spenser.** I or II; ¾ unit. GOLDMAN.

336. **English Drama Exclusive of Shakespeare.** From 1600 to 1700. I, II; ¾ unit. HERRICK.

338. **Tragedy.** Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. I, II; ¾ unit. ORNSTEIN.

339. **Comedy.** The history and theory of comic drama. I or II; ¾ unit. SHATTUCK.

342. **The Poetry of Milton.** Origins, forms, artistic and ethical values; Milton's place in English literary history. II; ¾ unit. FLETCHER.

345. **The Metaphysical Poets.** Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughan, Crashaw), with special emphasis on the poetry of John Donne. I or II; ¾ unit. EVANS, MILLIGAN.

346. **The Age of Dryden.** A study of Restoration literature, dramatic and nondramatic, centered around Dryden. I; ¾ unit. EVANS.

348. **Swift, Pope, and Fielding.** A study of the principal ideas and methods of satire as revealed in the writing of the three major English satirists. I, II; ¾ unit. Prerequisite: A course in English literature. HAIG.

349. **Dr. Johnson and His Circle.** The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan. Lectures establish the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. I, II; ¾ unit. HAIG.

351. **The Mid-Victorian Novel.** Thackeray, Emily Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. II; ¾ unit. HARKNESS, SCHNEIDER.

362. **The Art of the Lyric.** A study of lyric poetry as a genre. The examination of the nature of lyric convention and lyric originality through the reading of a body of related poems with special attention to the poetic manifestation of language and metaphor. II; ¾ unit. KRIEGER.

363. **Introduction to Comparative Literature.** A comparative study of great books in Greek, Roman, Italian, and Spanish literature. I; ½ unit. ALLEN, HOLADAY, LANDIS, PIETRANGELI.

364. **Introduction to Comparative Literature.** A comparative study of great books in French, German, and English literature. II; ½ unit. JACOB, LANDIS.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as Speech 371. I; ½ to 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism. Sidney to the Present.** Same as Speech 372. II; ½ to 1 unit. HERRICK.

382. **The Plays of Bernard Shaw.** I; ¾ unit. SHATTUCK.

383. **English Literature in the Twentieth Century.** An introductory survey emphasizing Shaw, the Edwardian novelists, Yeats, Joyce, Lawrence, Eliot, the Bloomsbury group, the satirists of the twenties, and such recent writers as Auden, Orwell, and Graham Greene. I; ¾ unit. HARKNESS.

387. **The Structure of English.** Same as Humanities 387. A consideration of the role of linguistics in writing and evaluating grammars; detailed treatment of a generative grammar of English. I or II; ¾ unit. SLEATOR.

American Literature

COURSES FOR GRADUATES

437. **Studies in American Literature: 1600 to 1800.** Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Enlightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. I; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: A survey course in American literature or consent of instructor. DAVIDSON.

486. **Problems in American Criticism and American Culture.** Papers and discussions on literary critics and historians who have used literature as an index to the problems of American culture, 1900-1959. Offered in 1961-1962 and in alternate years. I or II; 1 unit. PAUL.

487. **Problems in American Literature and Cultural History.** A conference and research course devoted to intensive studies in the relation of selected writers and problems in American literature to critical movements. I, II; 1 unit. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN, PAUL.

488. **Problems in American Literature and Cultural History.** Continuation of English 487. I, II; 1 unit. Prerequisite: A survey of American literature or consent of instructor. ALTENBERND, DAVIDSON, FLANAGAN, PAUL.

497. **Independent Reading.** A course in individual readings from the areas of literature as offered by the department at the advanced undergraduate-graduate level. May only be taken concurrent with a 300-level course. No student may offer more than a total of ½ unit of English 497. I, II; ¼ unit. Prerequisite: Consent of instructor of requisite 300-level course.

499. **Thesis Research.** Guidance in writing theses for advanced degrees, I, II; 0 to 4 units. ALTENBERND, DAVIDSON, FLANAGAN, HASKELL, KELLEY, PAUL, SCOTT.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. **The American Drama.** An historical survey of the American drama from Clyde Fitch to the present, including the reading of a large number of representative plays. II; ¾ unit. Offered in 1960-1961 and in alternate years. FLANAGAN.

318. **The American Novel: Cooper to Norris.** I, II; ¾ unit. DAVIDSON, HASKELL.

352. **American Literature: Irving to Whitman.** A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. II; ¾ unit. DAVIDSON, PAUL.

353. **Studies in Middle Western Literature.** A survey of Middle Western literature from about 1825 to Dreiser, with special emphasis on the development of realism in poetry and fiction. I; ¾ unit. Offered in 1961-1962 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

354. **Studies in Middle Western Literature.** A survey of Middle Western literature from Dreiser to the present, with special emphasis on the development of realism in poetry and fiction. II; ¾ unit. Offered in 1961-1962 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

357. **Folklore in American Literature.** A study of American folklore, including folktales, themes, and characters, with special references to the appearance of such material in American fiction, poetry, and drama. I; ¾ unit. FLANAGAN.

375. **Henry James and the Technique of Fiction.** A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. I; ¾ unit. Prerequisite: Consent of instructor. KELLEY.

376. **American Criticism and American Culture.** This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. II; ¾ unit. Prerequisite: English 113 and 114 or English 255 and 256. PAUL.

380. **Mark Twain and the Rise of Realism.** A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900. II; ¾ unit. SCOTT.

Rhetoric and Composition

COURSES FOR GRADUATES

480. **The Theory and Practice of English Composition.** An examination of modern prose style and consideration of problems confronting writers and teachers of writing. I, II; ½ unit. ROBERTS.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

388. **Linguistics in Language Learning.** Same as Humanities 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. I or II; ¾ unit. SLEATOR.

ENTOMOLOGY

The Department of Entomology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. A prerequisite for graduate work in entomology is a grade-point average of at least 3.5.

Previous training in entomology is not essential. It is recommended that students who intend to study for advanced degrees in entomology or to pursue an entomological career gain a thorough grounding in the fundamentals of physical and biological science, in mathematics and the other liberal arts, and in the techniques of communication. Otherwise it is necessary to take time from graduate studies to repair deficiencies in these areas.

Candidates for the degree of Master of Science in Entomology are required to earn two units of credit in a basic sequence that includes the fundamentals of insect morphology, insect physiology, and insect taxonomy, plus one unit each in more advanced courses in insect morphology, insect physiology, and insect control. Electives make up the balance of the eight-unit requirement. A reading examination in one foreign language must be passed during the first semester. Not more than two units of research credit may be elected, and if research credit is presented a thesis is required. The candidate must pass an oral examination covering the general field of entomology.

In addition to satisfying the general Graduate College requirements, candidates for the degree of Doctor of Philosophy in Entomology must pass the reading examination in a second foreign language not later than the end of their third semester of graduate study. They must have satisfied the department course requirements for the master's degree and must also earn one unit of credit in insect bionomics and one unit in insect taxonomy. The remainder of their program is made up of electives with due attention to satisfying the requirements in regard to major and minor fields of specialization.

There are four chief fields of specialization in the department: general entomology (including morphology and taxonomy), insect bionomics, applied entomology (including economic entomology, medical entomology, and toxicology of insecticides), and insect physiology. The department is well equipped to offer work in these areas, and the facilities of the State Natural History Survey are also available for advanced study. Outstanding entomological library facilities are located on the campus.

The requirements of the Department of Entomology in regard to minors are the following: If a sole minor is elected, it must involve four units outside the department in one of the following areas: agronomy, botany (including plant pathology), chemistry, horticulture, microbiology, physiology, and zoology. A first minor (two units) may be taken in a field of specialization in entomology other than the major, and the second minor (two units) must be in a related subject outside the department. For minors outside the Department of Entomology, the candidate should in all cases check the requirements both with his adviser and with the department concerned.

Doctoral candidates must pass an oral preliminary examination before entering the last year of residence. At the preliminary examination a candidate must exhibit a broad background in the whole field of entomology and a knowledge of general biological principles. A final oral examination is given after an acceptable thesis has been completed. At the option of the faculty, written examinations may also be required.

Theses required for the master's and doctor's degrees are due in the office of the Department of Entomology ten days before the date of the oral examination.

GRADUATE TEACHING FACULTY

Professors: L. E. Chadwick (Head of Department), G. C. Decker, G. Fraenkel, W. R. Horsfall, C. W. Kearns, H. H. Ross.
Associate Professor: J. G. Sternburg.
Assistant Professor: R. B. Selander.

COURSES FOR GRADUATES

410. **Insect Morphology.** A comprehensive study of the internal and external structure of insects, from the comparative viewpoint. II; 1 unit. Prerequisite: Entomology 301. Sternburg.

413. **Medical and Veterinary Entomology.** Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of disease among men and domestic animals. I; 1 unit. Prerequisite: Entomology 101, 103, or 301; or Zoology 320. Horsfall.

420. **Chemistry and Toxicology of Insecticides.** Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. II; 1 unit. Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. Kearns, Sternburg.

422. **Insect Physiology.** A study of the principal physiological and biochemical functions of insects, exclusive of sensory functions. II; 1 unit. Prerequisite: Entomology 301; a course in organic chemistry. Fraenkel.

423. **Insect Behavior.** An analysis of the physiological basis of insect behavior, including a thorough study of the physiology of the various sensory systems. I; 1 unit. Prerequisite: Entomology 301. Chadwick, Fraenkel.

426. **Seminar in Entomology.** Discussions, reviews, and appraisals of special topics in the field of entomology. I, II; ¼ to 1 unit. Prerequisite: Entomology 302; consent of instructor. Chadwick, Decker, Fraenkel, Horsfall, Kearns, Ross, Selander, Sternburg.

499. **Thesis Research.** Work may be taken in the following subjects: morphology and embryology of insects, applied entomology, systematic entomology, biology and ecology of insects, insect physiology. I, II; 0 to 4 units. Chadwick, Decker, Fraenkel, Horsfall, Kearns, Ross, Selander, Sternburg.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Advanced Entomology, I.** With Entomology 302, this course provides the necessary background for all further advanced work in the department. Entomology 301 is devoted to integrated studies of the principal morphological and physiological characteristics of insects, and is to be followed by similar systematic studies in Entomology 302. I; 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalents. Chadwick, Fraenkel, Sternberg.

302. **Introduction to Advanced Entomology, II.** With Entomology 301, this course provides the necessary background for all further advanced work in the department. Entomology 302 presents a comprehensive survey of the systematics and phylogeny of the orders and principal families of insects, together with practical experience in identification of these taxa. II; 1 unit. Prerequisite: Entomology 301. Selander.

306. **Special Problems.** For students ready to take up some special investigation

which may be completed as an undergraduate study or the beginning of a thesis problem for an advanced degree. May also be used to prepare a thesis for scholastic honors. I, II; ¼ to 1 unit. Prerequisite: Any of the following: Entomology 131, 301, 302, 317, 319, 322, or Zoology 101 or 321; senior standing. CHADWICK, DECKER, FRAENKEL, HORSFALL, KEARNS, ROSS, SELANDER, STERNBURG.

312. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelations with other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent.

317. **Classification of Insects.** Advanced study of the systematics and phylogeny of selected insect groups, with a presentation of the principles and methods of systematic entomology. I; 1 unit. Prerequisite: Entomology 302. SELANDER.

319. **Fundamentals of Insect Control.** The course emphasizes the principles that underlie effective control practices, rather than the details of methods used against specific pests. Both environmental and chemical factors involved in insect control are considered from their basic aspects. I; 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalent. HORSFALL, KEARNS, STERNBURG.

322. **Insect Bionomics.** This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. II; 1 unit. Prerequisite: Entomology 101, 103, or 301, or Zoology 320. HORSFALL.

FINANCE

The Department of Finance offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Finance. The following fields are available for specialization within the department: money, credit, and banking; corporation finance; corporation history; investment; insurance; urban land utilization.

The minimum grade-point average for admission to graduate study in finance is 3.5, and a candidate for a degree in finance must meet the general admission requirements of the Graduate College. He must also have had (1) at least twenty-seven hours of undergraduate work in social science, fifteen hours of which must have been in economics, including a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

A candidate who elects finance as a minor for either the master's degree or the doctorate must have had (1) at least twelve hours of undergraduate work in social science, eight hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

One year of graduate study in economic theory and a thesis are required as part of the minimum eight units for the master's degree in finance.

A candidate for the Ph.D. with a major in finance must pass a preliminary examination, by a doctoral committee, showing (1) a comprehensive knowledge of economic theory and at least one additional related field in economics; (2) a comprehensive knowledge of at least three fields of finance or closely allied fields, determined with approval of the adviser in consideration of the candidate's educational objective; (3) a general acquaintance with the subject matter and bibliography of the area of finance; (4) proficiency in any other field outside the department if offered as a minor. Graduate study in accountancy or statistics, or both, is advised strongly for doctoral candidates majoring in finance.

The Ph.D. program for the first year must include (1) two units of economic theory, (2) four units of finance, and (3) two additional units in finance or related fields. Two of the finance units should be in thesis research. The second year of study includes eight units which provide (1) a concentration in finance, (2) understanding of one or more fields in economics in addition to economic theory, and (3) proficiency in any other related minor field offered.

GRADUATE TEACHING FACULTY

Professors: P. M. Van Arsdell (Head of Department), R. O. Harvey, R. W. Mayer, R. I. Mehr, R. M. Nolen, R. C. Osborn, G. W. Woodworth.
Associate Professor: R. A. Hedges.
Assistant Professor: R. Hill.

COURSES FOR GRADUATES

420. **Central Banking Policy.** An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. I, II; 1 unit. Nolen.

425. **The Money Market and Financial Stabilization.** A study of interest rate determination; the structure and operations of the money and capital markets; the objectives and implementation of monetary, fiscal, and debt management policies: II; 1 unit. Prerequisite: Principles of Economics; Finance 250. Woodworth.

454. **Corporation Finance.** Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. I; 1 unit. Prerequisite: Finance 254. Van Arsdell.

455. **Corporation Finance.** Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. II; 1 unit. Prerequisite: Finance 254. Van Arsdell.

456. **Investment.** A study of the financial process by which savings are transformed into capital with emphasis on the theory of investment, on a critique of investment policy, and on the valuation of investment media. I; 1 unit. Mayer.

458. **Evolution of the Concept of the Business Corporation.** The antecedents, development, and financing of the corporation as a legal and economic institution; tracing its growth and change from early beginnings to the middle of the eighteenth century. I; 1 unit. Prerequisite: Principles of Economics; consent of instructor. Osborn.

459. **Evolution of the Concept of the Business Corporation.** The development and financing of the corporation as a legal and economic institution since the middle of the eighteenth century; the position of the corporation in the present economy; new developments in the corporation. II; 1 unit. Prerequisite: Principles of Economics; consent of instructor. OSBORN.

460. **Theory of Insurance.** A study of the nature and cost of risk in our society and of the methods of handling it. I, II; 1 unit. MEHR.

490. **Individual Study and Research.** Directed reading and research. I, II; ½ to 1 unit. STAFF.

499. **Thesis Research.** Required for those writing master's and doctor's theses in finance. I, II; 0 to 4 units. MAYER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

357. **Financing Small Business.** Size and nature of small business; significance and limitations of small business; financial structure and problems; financial assistance to small business; future prospects of small business. II; ½ to 1 unit. Prerequisite: Finance 254 or 257. OSBORN.

359. **Security Analysis.** Application of investment principles to investment policy; analytical principles and techniques; analysis of fixed income corporate securities, of senior securities with speculative features, of common stocks, of government and municipal securities, and of investment company securities. II; ½ to 1 unit. Prerequisite: Accountancy 108; Finance 254. MAYER.

360. **Group Insurance and Pensions.** Same as Labor and Industrial Relations 360. A study of the problems faced by management and labor in establishing employee benefit plans for death, disability, and retirement. Actual case problems are used in the course. I; ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Management 248. MEHR.

363. **Advanced Life Insurance.** A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. II; ½ to 1 unit. Prerequisite: Finance 262. MEHR.

366. **Casualty Insurance.** An examination of hazards, contracts, forms, rates, underwriting principles, and loss prevention activities in the following branches of insurance: workman's compensation, public liability, burglary, robbery, theft, glass, power plant, credit, accident and health, and fidelity and surety. I; ½ to 1 unit. Prerequisite: Finance 260. HEDGES.

367. **Problems in Insurance.** An analysis of problems dealing with the fitting of insurance coverages to the needs of business. The course considers the problems of surveying hazards, selecting policy forms, rating, underwriting, loss adjustment, loss prevention, and over-all insurance planning. II; ½ to 1 unit. Prerequisite: Finance 263 and 366. HEDGES, MEHR.

368. **Survey of Urban Real Estate.** A broad survey of the field of real estate land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. I; ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor. HARVEY.

369. **Urban Land Problems.** A problems course for students interested in undertaking detailed analysis of urban land problems. Problems are selected for individual study. Whenever possible the problems are selected and developed jointly with the Departments of City Planning and Landscape Architecture, Architecture, and others. II; ½ to 1 unit. Prerequisite: Finance 368 or consent of instructor. HARVEY.

FOOD TECHNOLOGY

(Including Dairy Technology)

The Department of Food Technology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in either Food Technology or Dairy Technology. Students undertaking graduate work in either field must have a grade-point average of at least 3.5 in the last sixty hours of work.

Minors may be selected from the fields of physical, biological, agricultural, or engineering science, economics, or management. Candidates for the degree of Doctor of Philosophy should complete formal course work and satisfy the language requirements (German and French or Spanish) by the end of the second year of residence so that a minimum of one year may be spent in research. Each candidate must take a comprehensive written examination before the oral preliminary examination for the doctorate.

Graduate credit courses offered outside the Department of Food Technology may be applied in partial satisfaction of the major unit requirements. These may be selected from closely related fields of study, such as bacteriology, chemistry, physics, engineering, and applied biological sciences, and are subject to the approval of the major department.

A student planning to take a major or minor in dairy technology should have had previous training as an undergraduate in this field. It is also desirable for the student to have had a course in statistics, advanced undergraduate training in mathematics and chemistry, and at least a year of French, Spanish, or German.

To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350, Dairy Technology 401 (one unit), 404 (one unit), and 499 (two units). A course in statistics is also necessary unless such a course was taken by the student when an undergraduate. The remainder of the eight units required for the Master of Science degree can be taken in the major and minor fields.

Second-year and third-year graduate students are expected to attend all seminars (Dairy Technology 404) in dairy technology, but they can register for a maximum of only one unit of credit. Dairy Technology 403 (one unit) and Dairy Technology 499 (eight units) are also required for the Ph.D. degree.

A student planning to take a major or minor in food technology should have a Bachelor of Science degree in a recognized field of biological, physical, agricultural, or engineering science in which a minimum of the undergraduate credits are as follows: biology, six hours; physics, eight hours; calculus, five hours; microbiology, five hours; analytical chemistry, five hours; organic chemistry, five hours; physical chemistry, four hours; and food technology or equivalent, twenty hours. Deficiencies in any of these requirements may be made up during the first year of graduate study, but no graduate credit is given.

To obtain a graduate degree in food technology, a student must have credit (graduate or undergraduate) in Chemistry 350, Microbiology 308, Food Technology 301, 302, 421 (M.S., one-half unit; Ph.D., one unit), and 499 (M.S., two units; Ph.D., eight units).

Research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing.

Candidates for the master's degree must complete one language requirement (German, French, or Spanish) and one minor and are required to take an examination covering the field of general food technology and of their specialization. This is primarily an oral examination although at the option of the faculty it may include a written section. The candidate must present a thesis unless this requirement is waived by petition to the department.

GRADUATE TEACHING FACULTY

Professors: R. T. Milner (Head of Department), E. O. Herreid, L. B. Howard, F. A. Kummerow, A. I. Nelson, Z. J. Ordal, S. L. Tuckey, R. M. Whitney.
Associate Professors: M. P. Steinberg, J. Tobias.
Assistant Professor: L. D. Witter.

Food Technology

COURSES FOR GRADUATES

404. **The Technology of Fats and Oils.** Lectures, reference readings, and demonstrations on the factors involving the technology of fats and oils. II; ½ unit. Prerequisite: Food Technology 391. Kummerow.

406. **The Technology of Fats and Oils.** Laboratory, reference readings, and demonstrations on the factors involving the technology of fats and oils. II; ½ unit. Prerequisite: Credit or registration in Food Technology 404. Kummerow.

421. **Seminar.** Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food technology. I, II; ½ unit. Staff.

430. **Carbohydrates in Foods.** Same as Home Economics 430. A study of the physical and chemical properties of carbohydrates used in foods and their behavior under conditions encountered in food processing and storage. I; ¾ unit. Prerequisite: Chemistry 350 or consent of instructor. Osman.

481. **Advanced Studies in Food Technology.** Library or laboratory assignments on specific problems of limited scope involving individual commodities or processes. I, II; ½ to 2 units. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, and dehydrating. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. I; 1 unit. Prerequisite: Food Technology 201 and 260, or equivalent. Nelson.

302. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats and poultry products; and vacuum and freeze drying of foods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. II; 1 unit. Prerequisite: Food Technology 202 and 301, or equivalent. Nelson.

332. **Principles of Sanitation in the Processing and Handling of Foods.** Same as Veterinary Medical Science 332. A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and microorganisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulations. Local field trips to food processing plants. II; ½ unit. Prerequisite: Bacteriology 104 and Chemistry 132, or equivalent. Ordal, Witter.

363. **Introduction to Process Engineering.** Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food technology; not open to majors in chemical engineering. Lectures and problems. I; ¾ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Chemistry 340 and 341 or 342; one year of calculus.

373. **Advanced Food Microbiology.** A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. I; 1¼ units. Offered in 1961-1962 and in alternate years. Prerequisite: Bacteriology 308 and Chemistry 133, or equivalent. Ordal, Witter.

391. **The Technology of Fats and Oils.** Lectures, reference readings, and demonstrations on the factors involving the technology of fats and oils. I; ½ unit. Prerequisite: Credit or registration in Chemistry 350 or consent of instructors. Kummerow.

393. **The Technology of Fats and Oils.** Laboratory exercises and demonstrations of factors involving the technology of fats and oils. I; ½ unit. Prerequisite: Credit or registration in Food Technology 391. Kummerow.

Dairy Technology

COURSES FOR GRADUATES

401. **Advanced Principles of Dairy Technology.** Study of fundamentals and fundamental problems involved in the processing of milk and milk products. I; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Chemistry 350. Herreid.

403. **Colloid Phenomena of Dairy and Other Food Products.** A study of the colloidal phenomena involved in the processing of dairy and other food products. II; 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Chemistry 249 or consent of instructor. Whitney.

404. **Seminar.** Review of current literature in dairy technology. Students may register for credit only twice for a maximum of one unit. I, II; 0 to ½ unit. Staff.

491. **Assigned Problems in Dairy Technology.** Research on special problems for graduate students with a major interest in dairy technology. I, II; ½ to 2 units. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Plant Management.** Problems in the organization, financing, labor management, and operation of dairy plants. II; ½ unit.

310. **Dairy Product Processing.** Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, dried milk, and ice cream. II; 1 unit. Prerequisite: Dairy Technology 101 and 211; credit or registration in Dairy Technology 213. Herreid.

311. **Dairy Product Processing.** Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter, butter oil, cheese, casein, lactic acid, lactose, and fermentation products of whey. I; 1 unit. Prerequisite: Dairy Technology 211 and 213. Tuckey.

312. **The Chemistry of Milk and Milk Products.** Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. I; ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 213 or Chemistry 122. WHITNEY.

FRENCH

The Department of French offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Students with a minimum grade-point average of 3.5 are regularly admitted to graduate courses in French, subject to fulfillment of other prerequisites.

Students electing French as a major subject should have had the equivalent of at least four years of French in college, including practical work in the use of the language and an advanced course in literature. Some knowledge of other Romance languages and literatures is desirable. A basic knowledge of Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Degree of Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates must pass an examination based on a general reading list. Candidates preparing to teach French must take French 407, 409, and 410 unless they can demonstrate proficiency.

Degree of Doctor of Philosophy in French. Candidates for this degree are required to include French 475 and 476, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject.

Degree of Master of Arts in the Teaching of French. Candidates for the degree of Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 407, 409, 410, two units; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields. In addition to these requirements, candidates must pass an examination based on a general reading list. The adviser for candidates for this degree is Professor J. F. Jackson, 226 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: C. A. KNUDSON (Head of Department), J. E. EHRHARD (Visiting), J. F. JACKSON, P. KOLB, P. A. WADSWORTH.
Associate Professor: C. P. VIENS.
Assistant Professor: R. E. HALLOWELL.

COURSES FOR GRADUATES

400. **Beginning French for Graduate Students.** Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. degree. I, II; 4 hours. No graduate credit.

401. **Reading French for Graduate Students.** Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. degree. I, II; 4 hours. No graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

407. **Advanced French Diction.** Training in the improvement of French pronunciation, with special attention to the problems of teachers. It is recommended that this course and French 409 be taken simultaneously. I; ½ unit. EHRHARD, VIENS.

409. **The Phonetics of French.** A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 407 be taken simultaneously. I; ½ unit. KNUDSON.

410. **Advanced Syntax.** An advanced theoretical and practical study of present-day French, with some consideration of stylistics. Conducted in French. II; 1 unit. EHRHARD, VIENS.

424. **Studies in French Poetry.** Versification, poetic structure, problems of imagery and meaning, and practical work in the interpretation of individual poems. S; 1 unit. WADSWORTH.

425. **Explication de textes, I.** Exercises according to the method of *explication de textes,* applied to texts selected principally from the period 1944-1958. I; 1 unit. Offered in 1960-1961 and in alternate years. EHRHARD.

426. **Explication de textes, II.** The French method of *explication de textes* applied to selected texts of the principal French writers, in particular the *penseurs et essayistes.* II; 1 unit. Offered in 1960-1961 and in alternate years. EHRHARD.

431. **History of Old French Literature, I.** Lectures on the history of French literature from the eleventh through the thirteenth century, with particular attention to epic and romance. Illustrative reading in translation. I; 1 unit. Offered in 1961-1962 and in alternate years. KNUDSON.

432. **History of Old French Literature, II.** II; 1 unit. Offered in 1961-1962 and in alternate years. KNUDSON.

433. **Villon, Rabelais.** I; 1 unit.

434. **Montaigne, La Pléiade.** II; 1 unit. HALLOWELL.

435. **Seventeenth-Century Literature, I.** I; 1 unit. Offered in 1961-1962 and in alternate years. WADSWORTH.

436. **Seventeenth-Century Literature, II.** II; 1 unit. Offered in 1961-1962 and in alternate years. WADSWORTH.

437. **Eighteenth-Century Literature, I.** I; 1 unit. Offered in 1960-1961 and in alternate years. WADSWORTH.

438. **Eighteenth-Century Literature, II.** II; 1 unit. Offered in 1960-1961 and in alternate years. WADSWORTH.

447. **Nineteenth-Century Literature to 1850, I.** I; 1 unit. Offered in 1960-1961 and in alternate years. JACKSON.

448. **Nineteenth-Century Literature to 1850, II.** II; 1 unit. Offered in 1960-1961 and in alternate years. JACKSON.

453. **French Realism and Naturalism, I.** I; 1 unit. Offered in 1961-1962 and in alternate years. JACKSON.

454. **French Realism and Naturalism, II.** II; 1 unit. Offered in 1961-1962 and in alternate years. JACKSON.

457. **Seminar in Proust, I.** I; ½ unit. Offered in 1961-1962 and in alternate years. KOLB.

458. **Seminar in Proust, II.** II; ½ unit. Offered in 1961-1962 and in alternate years. KOLB.

465. **La Littérature Contemporaine, I.** In French. Poetry. Baudelaire; symbolism up to Valéry. Prose writers from 1900 to 1940. I; 1 unit. Offered in 1961-1962 and in alternate years.

466. **La Littérature Contemporaine, II.** II; 1 unit. Offered in 1961-1962 and in alternate years.

475. **Old French Philology, I.** Reading of characteristic masterpieces of medieval French literature and study of the development of the Old French language from Latin. I; 1 to 1¼ units. Offered in 1960-1961 and in alternate years. Prerequisite: Consent of instructor; elementary knowledge of Latin; reading knowledge of German. KNUDSON.

476. **Old French Philology, II.** II; 1 to 1¼ units. Offered in 1960-1961 and in alternate years. Prerequisite: French 475. KNUDSON.

491. **Individual Topics.** I, II; ¼ to 1 unit. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The prerequisite for all courses in this group is French 201 and 202, or equivalent.

309. **Survey of French Literature, I.** I; ¾ unit. JACKSON.

310. **Survey of French Literature, II.** II; ¾ unit. JACKSON.

317. **Modern French Drama, I.** I; ½ unit. Offered in 1960-1961 and in alternate years. VIENS.

318. **Modern French Drama, II.** II; ½ unit. Offered in 1960-1961 and in alternate years. VIENS.

323. **French Drama of the Seventeenth and Eighteenth Centuries, I.** I; ¾ unit. Offered in 1961-1962 and in alternate years. KOLB.

324. **French Drama of the Seventeenth and Eighteenth Centuries, II.** II; ¾ unit. Offered in 1961-1962 and alternate years. KOLB.

331. **French Novel of the Nineteenth Century, I.** From Balzac to Proust. I; ¾ unit. Offered in 1960-1961 and in alternate years. KOLB.

332. **French Novel of the Nineteenth Century, II.** From Balzac to Proust. II; ¾ unit. Offered in 1960-1961 and in alternate years. KOLB.

333. **La Littérature Contemporaine, I.** In French. Modern poetry from Baudelaire to Valéry. Prose writers from 1900 to 1940. I; ½ unit. Offered in 1961-1962 and in alternate years.

334. **La Littérature Contemporaine, II.** II; ½ unit. Offered in 1961-1962 and in alternate years.

335. **Civilisation Française, I.** A survey of French life and French institutions, intended as a background for literary studies and as a preparation for the teaching of French. I; ½ unit. Offered in 1960-1961 and in alternate years. EHRHARD.

336. **Civilisation Française, II.** II; ½ unit. Offered in 1960-1961 and in alternate years. EHRHARD.

GENERAL ENGINEERING

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE TEACHING FACULTY

Professors: J. S. DOBROVOLNY (Head of Department), E. C. MCCLINTOCK, J. E. PEARSON, F. L. SPALDING, C. H. SPRINGER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Professional Expression.** Same as English 304. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. I, II; 1 unit. Prerequisite: Senior standing or consent of instructor. McClintock.

313. **Advanced Methods in Engineering Graphical Computations.** Application of determinants in the theory and construction of engineering nomograms; curve fitting and formulation of empirical formulae; methods and application of graphical calculus. II; ½ to 1 unit. Prerequisite: Mathematics 142 or equivalent.

330. **Industrial Standardization.** Evolution and history of standardization; local, national, and international standardization; governmental standardization procedures for individual industrial establishments as a tool of management. II; ½ unit. Prerequisite: Junior standing or consent of instructor. Spalding.

393. **Special Problems.** Study of advanced problems related to general engineering and graphics. II; ½ to 1 unit. Prerequisite: Senior standing or consent of instructor. Springer and others.

GENETICS

Students desiring a general training in genetics may take a major or minor in botany or zoology. Those desiring to approach agricultural problems through genetics may take a major or minor in agronomy, horticulture, animal science, or dairy science. For courses in the subject, see the Departments of Agronomy, Animal Science, Botany, Dairy Science, Horticulture, Microbiology, and Zoology. An interdepartmental genetics seminar is held at frequent intervals. Consult the University's weekly calendar for time and place.

GEOGRAPHY

The Department of Geography offers graduate work leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy. The following fields of geography are available for specialization in graduate study: climatology, economic geography, cartography, land utilization, conservation of resources, regional geography, political geography, historical geography, and educational geography.

Students applying for admission must have a 3.75 grade-point average. All candidates for advanced degrees in geography must have an average of at least 4.0 in previous work in geography.

Degree of Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose background is largely in physical geography are recommended for the degree of Master of Science; others receive the degree of Master of Arts. The program leading to the master's degree in geography is to add breadth to the student's geographic knowledge and to introduce the student to semi-independent accumulation and use of the geographic materials in seminars, and to independent research and advanced study. Adequate latitude in course requirements is provided to allow the candidate to complete his understanding of the broad aspects of geography (depending on his undergraduate concentration) and to begin to penetrate more deeply into specific phases of

geographic content. In this way the master's degree can either be a terminal degree or lead directly into the more intensive study toward the doctorate.

At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. In individual cases, additional units of work may be required by the departmental graduate committee. Students must have had, either as undergraduates or as graduates, training in climatology, map construction and map reading and interpretation, introductory field work, cultural geography, and regional geography. They must also have proficiency equivalent to that expected of an Illinois undergraduate major in a physical or biological science, in a social science, in statistical method, and in oral and written expression. Geology, botany, soils, or zoology are recommended as physical or biological sciences; economics, history, political science, sociology, or anthropology are recommended in the social sciences.

Degree of Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are electives, two units in education, and two units in electives. Requirements are Geography 495, two units; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in geography and the other electives must be selected with the approval of the adviser. Two electives must be in geography and the other two in geography, education, or, in exceptional cases, other fields. The grade-point average required for admission is 3.5. The adviser for candidates for this degree is Professor J. H. Garland, 224 Davenport Hall.

Degree of Doctor of Philosophy. The doctoral program presupposes an understanding of geographic patterns. This program is, therefore, intended to increase the student's ability to use his knowledge of geography and its allied fields and to provide maximum opportunity for the exercise of independent ability. The doctoral student is expected to penetrate deeply into the content, techniques, implications, and significance of specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world.

Candidates for the degree of Doctor of Philosophy in Geography must have taken, either as an undergraduate or as a graduate, all work or the equivalent which is required in the undergraduate major and the master's and doctor's programs of the department. Eight of the minimum twenty-four units of graduate credit required for the Doctor of Philosophy degree must be in Geography 499 and are devoted to the completion of an original and independent doctoral thesis. Geography 499 is carried subsequent to the admission of the student to candidacy for the degree.

The work required for a Doctor of Philosophy degree in geography is divided into two phases, first, that of preparing a student for formal admission to candidacy for the degree, and second, the satisfactory completion of the doctor's thesis and the support of the thesis in an examination.

Admission to candidacy for the Doctor of Philosophy degree in geography is recommended after the successful completion of the following requirements:

(1) At least sixteen units of graduate credit, or equivalent, including four units in official minor fields. At least nine of these sixteen units must be in geography. The department recommends a split minor, consisting of at least two units in each field. One of the minors should be in geology, botany, soils, or zoology, the other in anthropology, economics, history, political science, sociology, or Latin American studies. Other minor fields may be accepted upon recommendation of the major adviser.

(2) The required examinations in foreign languages.

(3) A preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College. The examination covers selected

divisions of physical, cultural, and regional geography, the techniques and theory of the discipline, and the student's minor fields.

After being admitted to candidacy for the Doctor of Philosophy degree, the student must complete a research thesis which demonstrates his capacity to complete and to support independent and original work in geography. The doctoral thesis normally requires field investigation.

GRADUATE TEACHING FACULTY

Professors: J. A. Russell (Head of Department), A. W. Booth, F. W. Foster, J. H. Garland, J. L. Page.
Associate Professors: R. L. Carmin, J. D. Fellmann, H. G. Roepke.
Assistant Professor: C. Alexander.

COURSES FOR GRADUATES

412. **Analytical Climatology.** A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. II; 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Page.

421. **Regional Concepts in Geography.** Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. II; ½ unit. Prerequisite: Nine hours of regional geography. Garland.

441. **Fundamentals of Bioclimatology.** Same as Physiology 441. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological and pathophysiological processes in mammals, and the application of meteorological, climatological, and geographical techniques in physiological studies. I or II; ¾ unit. Prerequisite: Consent of instructor. Page, Sargent.

442. **Experimental Bioclimatology.** Same as Physiology 442. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. I or II; ½ unit. Prerequisite: Physiology 306 and 307; credit or registration in Geography 441. Page, Sargent.

443. **Advanced Human Bioclimatology.** Same as Physiology 443. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. I or II; ½ unit. Prerequisite: Geography 441. Page, Sargent.

463. **Historical Geography.** Objectives and methods of historical geography. II; 1 unit. Fellmann.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. I, II; 1 unit. Prerequisite: Geography 373 or consent of instructor. Foster.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. I, II; 1 unit. Foster.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. Staff.

495. **Advanced Studies in Geography.** Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. I, II; ½ to 2 units. Work may be taken in the following fields:

(a) **Anglo-America.** GARLAND.
(b) **Latin America.** CARMIN.
(c) **Europe.** FOSTER, ROEPKE.
(d) **Asia.** BOOTH, RUSSELL.
(e) **U.S.S.R.** FELLMANN.
(f) **Australia and Oceania.** RUSSELL.
(g) **Economic Geography.** ROEPKE, RUSSELL.
(h) **Political Geography.** GARLAND.
(i) **Urban Geography.** CARMIN, FELLMANN.
(j) **Physical Geography.** BOOTH.
(k) **Mathematical Geography.** BOOTH.
(l) **Land Utilization and Conservation.** BOOTH, FOSTER, ROEPKE, RUSSELL.
(m) **Transportation Geography.** BOOTH, FELLMANN, FOSTER.
(n) **Problems of Geographic Study.** STAFF.

497. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. I; ½ unit. FELLMANN.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

313. **Climates of the Continents.** A regional treatment of the climates of the world by continents. I; ½ unit. Prerequisite: Geography 101 and 111. PAGE.

314. **Regional Problems in Conservation of Natural Resources.** The distribution, use, and interrelationship of the resources in the various resource management regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. II; ½ unit. Prerequisite: A previous course in conservation, or workshop or field work training in conservation. BOOTH.

332. **Geography of South America.** A regional geography of South America with emphasis on the southern hemisphere of that continent. II; ½ unit. Prerequisite: Eight hours of geography or enrollment in Latin-American studies program. CARMIN.

342. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. II; ½ unit. Prerequisite: Eight hours of geography. FOSTER.

350. **Geography of World Islands Including Australia.** Physical and cultural landscapes of Australia and the major island groups as habitats for man. II; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

351. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. I; ½ unit. Prerequisite: Eight hours of geography. BOOTH.

353. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and transportation. I; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. FELLMANN.

55. **Geography of Central and South Africa.** A regional geography of Africa south of the Sahara. II; ½ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

61. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. II; ½ unit. Prerequisite: One course in geography or enrollment in the College of Agriculture. ROEPKE.

62. **Manufacturing Regions of the World.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. I; ½ unit. Prerequisite: One course in geography. ROEPKE.

63. **Production of Great World Minerals.** Geographic aspects of the mineral industries. II; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Eight hours of geography. ROEPKE.

65. **Geographic Aspects of Transportation.** Geographic factors influencing transportation by land, sea, and air. II; ½ unit. Prerequisite: Eight hours of geography. BOOTH.

66. **Problems of Industrial Location.** The relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites. II; ½ unit. Prerequisite: Eight hours of geography. RUSSELL.

371. **Introduction to Research.** Introductory training in the techniques and source materials of geographic research. Limited to students whose major is geography and to seniors whose major is in other departments but who have twelve hours of geography. I, II; ½ unit. FELLMANN and others.

372. **Introduction to Research.** Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. II; ½ unit. STAFF.

373. **Map Compilation and Construction.** Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. I, II; 1 unit. Prerequisite: Consent of instructor. FOSTER.

375. **Map Reading and Interpretation.** Evaluation of map components, map reading, map interpretation, map history, and survey of world maps and mapping. I; ½ unit. Prerequisite: Consent of instructor. CARMIN.

378. **Descriptive Interpretation of Aerial Photographs.** Reading and interpreting of aerial photographs; their potentialities and limitations as a research tool of geography. II; ½ unit. Prerequisite: Consent of instructor. BOOTH.

383. **Urban Geography.** The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. II; 1 unit. Prerequisite: Eight hours of geography or consent of instructor. FELLMANN.

386. **Political Geography.** World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; western hemisphere nations. I; ½ unit. Prerequisite: Eight hours of geography. Major or graduate students in political science or history may enroll with consent of instructor. GARLAND.

GEOLOGY

Graduate students may take work in geology leading to the degrees of Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, economic geology, geomorphology and glacial geology, mineralogy and petrography, paleontology and stratigraphy, ground-water geology, and sedimentation.

Beginning graduate students in geology must have a grade-point average no lower than 3.75.

For graduate work in geology a student must have had (or take as a graduate student) undergraduate courses in physical geology, historical geology, mineralogy, geomorphology, structural geology, paleontology, stratigraphy, summer field course, chemistry, physics, and mathematics.

A candidate for the doctor's degree may select a minor in chemistry, physics, mining engineering, zoology, botany, agronomy, or geography. Other minors may be chosen with departmental approval.

GRADUATE TEACHING FACULTY

Professors: G. W. WHITE (Head of Department), A. CAROZZI, C. A. CHAPMAN, D. U. DEERE, R. E. GRIM, A. F. HAGNER, J. L. HOUGH, G. B. MAXEY, H. W. SCOTT, P. R. SHAFFER, H. R. WANLESS.

Associate Professor: D. M. HENDERSON.

Assistant Professors: F. L. KOUCKY, JR., R. LANGENHEIM.

COURSES FOR GRADUATES

401. **Advanced Dynamic Geology.** A study of geologic processes and their effects. I; 1 unit. Offered in 1961-1962 and in alternate years. WANLESS.

402. **Advanced Historical Geology.** Principles of interpretation and problems of earth history. II; 1 unit. Offered in 1960-1961 and in alternate years. WANLESS.

409. **Sedimentation.** II; 1 unit. WANLESS.

415. **Geology of the Upper Mississippi Valley.** Field study of the geology of Illinois and adjacent states by means of five or six two-day field trips and the preparation of reports; estimated travel expense, $60. I; 1 unit. LANGENHEIM.

422. **Stratigraphic Geology: Paleozoic.** I; 1 unit. Prerequisite: Geology 321. SCOTT.

423. **Stratigraphic Geology: Mesozoic and Cenozoic.** II; 1 unit. Prerequisite: Geology 321. LANGENHEIM.

425. **Micropaleontology: Foraminifera.** Classification of microfossils, foraminifera; stratigraphic correlation. I; 1 unit. Prerequisite: Geology 320 or Zoology 320. SCOTT.

426. **Micropaleontology: Ostracoda.** Classification of microfossils, ostracodes, conodonts, scolecodonts, and other major groups; stratigraphic correlations. II; 1 unit. Prerequisite: Geology 320 or Zoology 320. SCOTT.

28. **Palynology.** Same as Botany 428. The study of pollen and other spores with emphasis on their evolution, paleoecological significance, stratigraphic application, and methods of preparation for study. I; ½ to 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Geology 101 or Botany 120, or consent of instructor. KOSANKE.

35. **Igneous Petrology.** The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory a study is made of selected rock suites, and special methods of petrographical investigation are covered. I; 1 unit. CHAPMAN.

36. **Metamorphic Petrology.** Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied and special methods of investigation are covered. II; 1 unit. CHAPMAN.

37. **Sedimentary Petrology.** Study of the texture, composition, and structures of sedimentary rocks, with emphasis on laboratory methods of petrographical investigation; the classification of sedimentary rocks and a summary of the sedimentation portion of the petrologic cycle. I; 1 unit. HOUGH.

40. **Mineragraphy.** Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. I; 1 unit. HAGNER.

43. **Mineral Deposits.** Principles of mineral deposition and genesis of mineral deposits. I; 1 unit. Prerequisite: Geology 311. HAGNER.

44. **Mineral Deposits.** Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. II; 1 unit. Prerequisite: Geology 443. HAGNER.

46. **Petroleum Geology: Principles.** I; 1 unit. Offered in 1961-1962 and in alternate years. HOUGH.

50. **Geology for Civil Engineers.** Advanced physical geology, with emphasis on the geological aspects of civil engineering. I; 1 unit. Prerequisite: Geology 150 or equivalent. DEERE.

61. **Mineralogy of Clays.** The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. I; 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

62. **Mineralogy of Clays.** The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. II; 1 unit. Prerequisite: Geology 461. GRIM.

93. **Advanced Studies in Geology.** I, II; ½ to 2 units. Work may be taken in the following fields:

(a) **Clay Mineralogy.** GRIM.
(b) **Engineering Geology.** DEERE, HOUGH.
(c) **Geomorphology and Glacial Geology.** SHAFFER, WHITE.
(d) **Ground-Water Geology.** MAXEY.
(e) **Micropaleontology.** SCOTT.
(f) **Mineral Deposits.** HAGNER.
(g) **Mineralogy and Crystallography.** HENDERSON.
(h) **Paleobotany.** (See Botany 493i). KOSANKE, STEWART.
(i) **Paleontology.** HAY, SCOTT.
(j) **Pennsylvanian Stratigraphy.** WANLESS.
(k) **Petrography and Petrology.** CHAPMAN.
(l) **Sedimentary Petrology.** CAROZZI, HOUGH, WANLESS.
(m) **Stratigraphy.** LANGENHEIM, SCOTT.

99. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Geomorphology.** The study of the history, origin, and characteristics (land forms produced by fluvial, glacial, wind, and wave erosion, or by combination of these, acting upon the major kinds of geologic materia and structures. Lectures, laboratory, and field trips. I, II; 1 unit. Prerequ site: Geology 102. SHAFFER, WHITE.

311. **Structural Geology.** Rock deformation and its results. Lectures, laborator and field trip. I, II; 1 unit. Prerequisite: Geology 102; General Enginee ing 205 or consent of instructor. CAROZZI.

315. **Field Methods.** Mapping of an area in southern Illinois or western Ker tucky during Easter vacation. Credit is given only on completion of satisfactory written report. II; ½ unit. Prerequisite: Geology 102. WANLES

316. **Field Geology.** Geology of the Baraboo, Wisconsin, region. Field cours covering structural, stratigraphic, glacial, and physiographic features. Em phasis is on methods of study and interpretation. A comprehensive repo is required to provide training in geological report writing. Credit is give only on completion of a satisfactory written report. S; 1 unit. Prerequisite Geology 102 or equivalent; consent of instructor. HOUGH.

317. **Field Geology in the Rocky Mountains.** Field course conducted from a lo cality in the Rocky Mountains. Field training in stratigraphy, structure, an geomorphology; geologic mapping with plane table, and aerial photograph Approximate cost, $250.00 to $305.00. S; 2 units. Prerequisite: Geolog 102; consent of instructor.

320. **Invertebrate Paleontology.** Fossil groups in biological sequence. Lecture and laboratory. I, II; 1 unit. Prerequisite: Geology 102. HAY.

321. **Stratigraphy.** Stratigraphy-fossil faunas, with special reference to inverte brates, correlation, and stratigraphy. I, II; 1 unit. Prerequisite: Geolog 320. SCOTT.

324. **Vertebrate Paleontology.** Same as Zoology 324. Phylogeny, morphology and ecology of the fossil vertebrates. Lecture, laboratory, and field trips I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite Zoology 132 or Geology 102. BADER.

325. **Paleobotany.** Same as Botany 325. The structure, phylogeny, and geologica distribution of representative fossil plants. Two or three field trips. II; ½ or 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Geol ogy 101 and Botany 100 or Division of General Studies 131 and 132; o consent of instructor. STEWART.

335. **Optical Mineralogy.** Study of the optical properties of minerals and the us of the petrographic microscope. Emphasis is on the identification of mineral by the immersion method. Designed for students in geology, ceramics chemistry, mining, and agriculture. I; 1 unit. Prerequisite: Geology 132 CHAPMAN.

336. **Petrography.** Study of the constituents, composition, textures, structures and classification of rocks. In the laboratory, rocks are studied in hand speci men and thin section. Emphasis is on the ordinary methods of petrographica investigation. II; 1 unit. Prerequisite: Geology 335. CHAPMAN.

351. **Geophysical Prospecting.** Same as Mining Engineering 351. Principles o geophysics and their application to mining processes. I; 1 unit. WUERKER

354. **Mining Geology.** Same as Mining Engineering 354. Principles of ore depo sition; relation of mineralogic and structural features to prospecting, explora tion, development, and valuation of ore deposits. II; ¾ to 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Geology 101 or 150 Geology 130 or 131. WRIGHT.

GERMAN

Including Scandinavian)

The Department of German offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Students applying for admission must have a 3.75 grade-point average. Students should have completed a four-year course of undergraduate study in German corresponding to the four-year course at this University. They should be familiar with the principal works of the writers of the classical and modern periods of German literature, possess a general knowledge in the history of German letters and civilization, and be able to follow lectures in the German language. Acquaintance with German history, philosophy, and art in their relation to the general European background is highly desirable. A reading knowledge of French is important and is required for advanced graduate work. Some fluency in Latin is also recommended.

Fields of concentration for advanced degrees include German philology and linguistics, older literature, and modern literature.

Candidates for the degree of Master of Arts in the Teaching of German must earn four units in German, two units in education, and two units in electives. Requirements are: German, two or two and one-half units to be chosen from German 301, 302, 311, 312, 320, 331, 332, 415, or 416; one and one-half to two units from German courses open only to graduates; education, two units, including two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives must be selected with the approval of the adviser. The adviser for candidates for this degree is Professor Mimi I. Jehle, 217 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: J. R. Frey, P. M. Mitchell, E. A. Philippson, H. Stegemeier.
Associate Professors: F. G. Banta (Chairman of Department), Mimi I. Jehle, F. J. Nock.
Assistant Professor: Pauline S. Schwalbe.

German

COURSES FOR GRADUATES

400. **Beginning German for Graduate Students.** Introduction to the reading of German texts in the sciences and the humanities. I, II; 4 hours. No graduate credit. Nock.

401. **Readings in German for Graduate Students.** Designed for graduate students preparing for the German reading requirements for the Ph.D. degree. I, II; 4 hours. No graduate credit. Prerequisite: German 400 or equivalent. Nock.

411. **Proseminar.** Methods of literary criticism and research. I or II; 1 unit. Staff.

415. **Middle High German.** I; 1 unit. Banta.

416. **Middle High German Literature.** II; 1 unit. Prerequisite: German 415 or equivalent. Nock.

420. **History of the German Language.** II; 1 unit. Philippson.

426. **Gothic.** An introduction to Germanic (comparative) linguistics. II; 1 unit. Offered in 1961-1962 and in alternate years. Banta.

431. **German Literature of the Middle Ages.** German literature from 800 to 1400. I; 1 unit. Offered in 1961-1962 and in alternate years. Philippson.

432. **German Literature from 1400 to 1700.** Renaissance, Reformation, an Baroque in German literature. Lectures and readings. II; 1 unit. Offere in 1961-1962 and in alternate years. PHILIPPSON.

441. **German Romanticism.** I; 1 unit. Offered in 1961-1962 and in alternat years. MITCHELL.

442. **Nineteenth-Century German Realism.** II; 1 unit. Offered in 1961-1962 an in alternate years. FREY.

445. **Old High German.** Grammar and interpretation of the oldest literary docu ments. I or II; 1 unit. Offered in 1960-1961 and in alternate years PHILIPPSON.

451. **Naturalism, Symbolism, Expressionism.** German literature from the 1880' to the 1920's. I; 1 unit. Offered in 1960-1961 and in alternate years. FREY

452. **German Literature from the Twenties to the Present.** II; 1 unit. Offered i 1960-1961 and in alternate years. FREY.

460. **Seminar in German Literature.** Advanced research work in German litera ture; discussion of problems and papers. I or II; 1 unit. STAFF.

493. **Research in Special Topics.** I, II; 1 to 4 units. STAFF.

495. **Bibliography and Methods of Literary History.** To be taken concurrentl with German 411. I or II; ½ unit. FREY.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **German Literature to 1700.** I; 1 unit. Prerequisite: Three years of colleg German or equivalent. FREY.

302. **German Literature Since 1700.** II; 1 unit. Prerequisite: Three years of col lege German or equivalent. FREY.

303. **Conversation, Composition, and Syntax.** Intensive study of advanced prob lems of grammar, syntax, and style. I; ½ unit. Prerequisite: Three years o college German including German 212, or consent of instructor. JEHLE.

304. **Advanced Conversation.** Practice in free conversation with native speaker II; 0 units. Prerequisite: German 303 or equivalent. JEHLE.

311. **Goethe.** Introduction to Goethe's life and works. I; 1 unit. Offered i 1960-1961 and in alternate years. Prerequisite: Three years of colleg German. MITCHELL.

312. **Goethe's *Faust*.** Intensive study of Goethe's *Faust*, Parts I and II. II; unit. Offered in 1960-1961 and in alternate years. Prerequisite: Three year of college German or equivalent. MITCHELL.

320. **History of German Civilization.** A selected topical, historical, and pictoria analysis of German culture and civilization. I or II; 1 unit. Prerequisite Three years of college German or equivalent. STEGEMEIER.

331. **The Age of Lessing.** I; 1 unit. Offered in 1961-1962 and in alternate years Prerequisite: Three years of college German or equivalent. FREY and others.

332. **Schiller.** II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Three years of college German or equivalent. STEGEMEIER and others.

360. **Introduction to German Phonetics.** I; ½ unit. NOCK.

Scandinavian

COURSES FOR GRADUATES

405. **Old Norse-Icelandic, I.** Grammar and selected readings. I; 1 unit. Offered in 1961-1962 and in alternate years. MITCHELL.

406. **Old Norse-Icelandic, II.** Readings. Selections from the Elder Edda and the sagas. II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Scandinavian 405. MITCHELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

361. **Ibsen.** The dramas in English translation; selected works of Ibsen's Scandinavian contemporaries. II; 1 unit. Offered in 1961-1962 and in alternate years. MITCHELL.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs develops programs of training for the public service, provides in-service training for state and local government employees, holds institutes and conferences for citizens and public officials, and carries out a research program in the field of government and public affairs. The institute serves as a planning and directing agency to correlate the work of existing colleges and departments in the field of public affairs.

HEALTH AND SAFETY EDUCATION

The Department of Health and Safety Education offers a program of graduate study leading to the degree of Master of Science in Health Education. This program is centered in training teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for training in the special fields of public health education, and safety education.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5; (2) thirty semester hours of approved undergraduate credit in health education or closely related courses; (3) twenty-four semester hours of approved undergraduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement.

Graduation requirements for this degree are eight units to include (1) four units in health education or approved courses in physical education; (2) two units in education, including two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit; (3) registration in and satisfactory completion of Health Education 490, no credit; (4) presentation of an acceptable thesis in health education, two units. Candidates may petition to waive the thesis and seminar requirements. Those who are excused are required to secure two units' credit in lieu of thesis credit and in addition are required to take and pass a final comprehensive written examination in health education.

GRADUATE TEACHING FACULTY

Professors: H. S. HOYMAN (Head of Department), A. E. FLORIO, G. T. STAFFORD.
Associate Professors: F. E. BOYS, GERTRUDE B. COUCH.
Assistant Professor: W. J. HUFFMAN.
Instructors: C. A. BRIDGER, ISABELLE CRAWFORD, E. WITTENBORN.

Health Education

COURSES FOR GRADUATES

400. **Scientific Foundations of Health Education.** Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and prin-

ciples as these apply to the further improvement of personal, family, and community health. I or II; 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. HOYMAN, STAFFORD.

401. **Problems in School Health Education.** History, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. I or II; 1 unit. HOYMAN, STAFFORD.

403. **Problems in Public Health.** Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. I or II; 1 unit. STAFFORD.

404. **Trends and Issues in Sex Education.** A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of philosophy, principles, methods, and current problems. I or II; 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, or consent of instructor. HOYMAN.

490. **Seminar.** Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. I or II; no credit. STAFF.

493. **Special Projects.** Individual research in school health and safety education. I, II; ½ to 1 unit. Prerequisite: Education 390, Physical Education 495, and Health Education 400, or equivalent. STAFF.

499. **Thesis Research.** Preparation of theses in health and safety education. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

390. **Public Health Education.** Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers. Projects in preparing and using public health education materials. Evaluation of research in public health education. I; ½ unit. Prerequisite: Consent of instructor. WITTENBORN.

391. **Public Health Statistics.** An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. II; ½ unit. Prerequisite: Mathematics 161 or Education 390, or equivalent. BRIDGER, CRAWFORD.

Safety Education

COURSES FOR GRADUATES

402. **Problems in Safety Education.** Philosophy of safety; traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. I or II; 1 unit. FLORIO, STAFFORD.

HISTORY

The Department of History offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Graduate work in history presupposes

two years of college work in this subject, or at least sixteen semester hours, which should include courses in European and American history. Linguistic preparation, especially in French and German, is important. For ancient and medieval history some knowledge of Latin is essential. Spanish is useful for certain fields of American and Latin-American history. To be admitted to full standing in the Department of History, beginning graduate students must have a grade-point average no lower than 3.5.

Graduate courses in history at the University of Illinois are of three kinds: (1) lecture courses providing information, interpretation, and guidance in general reading; (2) instruction in methodology, historiography, and bibliography (History 495 and 496 are required of all graduate students in history during their first year); (3) seminars for the study of special fields with a view to training in methods of historical criticism and research and in the writing and presentation of historical essays.

Degree of Master of Arts. During his first term each candidate for this degree must demonstrate a satisfactory knowledge of history, such as would result from a sound undergraduate major program in the subject, by passing a comprehensive examination. Questions are given in the following four fields of history: ancient and medieval, modern European, English, and American. Candidates must answer questions in at least three of the four fields. Failure to pass the examination ordinarily results in the termination of candidacy for the degree, unless the candidate satisfies special requirements justifying reinstatement. Each candidate is expected to devote special attention to two of the following fields: ancient history, medieval history of continental Europe, modern history of continental Europe, English history, American history, Latin-American history, and the history of the Near East. Each candidate must write a master's thesis in one of his fields of specialization. To constitute a field of specialization a minimum of two units of graduate study is ordinarily required. Each candidate must have a reading knowledge of one foreign language, ordinarily French or German, as demonstrated by an examination administered by the department.

Graduate study in history may also be pursued in connection with the degrees of Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see page 275).

Degree of Doctor of Philosophy. Candidates who have not previously taken the departmental comprehensive examination are required to do so during their first semester of study in this program.

The candidate who selects history as his major subject should prepare himself for a preliminary examination in five fields, of which four are normally in history and one is in an outside related subject.

The preparation of the candidate should include a minimum of four units in the field of history in which he wishes to specialize and in which his thesis is to be written. This field constitutes his major.

There should be a minimum of three units in a second field known as the first minor, and of two units each in three other fields. One of these, outside the department, constitutes the second minor.

The Department of History offers the following fields of specialization and preparation: ancient history, medieval history, continental Europe from 1300 to 1648 (Renaissance and Reformation), continental Europe and its dependencies since 1648, England and its dependencies, the United States, Latin America, the Near East and Middle East, and the Far East. This enumeration of fields is not to be regarded as excluding the possibility of accepting others as may be determined by the department in individual cases.

The second minor field may be selected from the following departments and areas, although other suitable second minors may be arranged through consultation with department advisers:

Political Science. International law and diplomacy, modern government, m nicipal government, constitutional and administrative law and jurisprudenc political theory.

Economics and Sociology. Economic history, economic theory, public ar private finance, social reform, principles of sociology.

Philosophy and Education. History of ancient and medieval philosoph history of modern philosophy, history of education.

Literature. Some division of the history of literature, which may be eith comparative literature of a limited period or the literature of a particular countr for a more extended period as may be agreed upon in each case.

Graduate students have an opportunity to pursue research in connection wit the Illinois Historical Survey, an organization carrying on systematic studies i the history of the Midwest. Through the use of materials collected by this surve graduate students in the department are able to obtain useful training in the stud of manuscript as well as printed materials.

Doctoral candidates interested in specializing in American culture may elec a major in American history with a first minor (three-unit field) in America literature, and the second minor (two-unit field) in the history of fine arts in th United States.

GRADUATE TEACHING FACULTY

Professors: N. A. Graebner (Chairman of Department), A. E. Bestor, C. E Dawn, E. L. Erickson, R. T. Fisher, Jr., D. Geanakoplos, C. E Nowell, F. A. Shannon, C. G. Starr (Acting Chairman o Department, 1960-1961), R. P. Stearns.

Associate Professors: J. L. Bates, R. W. Johannsen, M. D. Lee, J. B. Sirich R. M. Sutton.

Assistant Professors: Louise B. Dunbar, O. P. Pflanze, Mary L. Shay.

COURSES FOR GRADUATES

401. **Seminar in Medieval History.** Studies in the Crusades and the Early Renaissance. I, II; 1 unit. Geanakoplos.
409. **Early Modern Europe to 1815.** A graduate survey of problems and sources. I; 1 unit. Stearns.
410. **Modern Europe since 1815.** A graduate survey of problems and sources. II; 1 unit. Pflanze.
411. **The French Revolution and Napoleon.** A seminar in the history of France and her relations with Europe, 1789 to 1815. I or II; 1 unit. Sirich.
414. **Seminar in Modern History: The Enlightenment.** II; 1 unit. Stearns.
415. **Seminar in the History of Europe Since 1815.** I; 1 unit. Pflanze.
419. **Seminar in Modern Russian History.** I; 1 unit. Fisher.
431. **Seminar in English History.** I; 1 unit. Erickson.
432. **Seminar in English History.** II; 1 unit. Lee.
452. **Seminar in American History.** I or II; 1 unit. Johannsen.
453. **Seminar in the Social History of the United States Before 1860.** I; 1 unit. Shannon.
454. **Seminar in the Social History of the United States Since 1860.** II; 1 unit. Shannon.
456. **Seminar in American Diplomatic History.** I or II; 1 unit. Graebner.
458. **Seminar in American History: The Revolutionary Period.** I, II; 1 unit. Dunbar.
461. **Seminar in Recent American History.** I or II; 1 unit. Bates.

72. **Seminar in the Intellectual and Constitutional History of the United States.** II; 1 unit. BESTOR.

73. **Graduate Survey of American History to 1865.** I; 1 unit.

74. **Graduate Survey of American History Since 1865.** II; 1 unit.

76. **Seminar in Latin-American History: The Revolutionary Period.** Latin America during the first half of the nineteenth century. Research in special topics. I or II; 1 unit. NOWELL.

82. **Seminar in Ancient History.** I; 1 unit. STARR.

95. **Historical Method.** Required of all candidates for an advanced degree in history who do not present evidence of similar training elsewhere. I; 1 unit. BESTOR.

96. **History of Historiography.** Introduction to the great historians from early times to the present. II; 1 unit. STARR.

99. **Thesis Research.** Individual direction in research and guidance in writing theses for advanced degrees. I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The general prerequisite for all graduate students registering in 300-numbered courses is one year of college history or consent of instructor.

301. **The Middle Ages from 400 to 1100 A.D.** Europe from the fall of Rome to the first crusade. I; ½ to 1 unit. GEANAKOPLOS.

302. **The Middle Ages from 1100 to 1500 A.D.** Europe from the rise of towns to the establishment of national monarchy. II; ½ to 1 unit. GEANAKOPLOS.

303. **History of Byzantine Civilization.** A study of the cultural, religious, and social history of the Eastern Roman Empire from Constantinople's foundation in 330 A.D., to the fall of Byzantium in 1453. Special attention is given to the continuation of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. I; ½ to 1 unit. GEANAKOPLOS.

304. **Medieval Civilization.** Religious and intellectual. II; ½ to 1 unit. GEANAKOPLOS.

305. **The Age of the Renaissance.** I; ½ to 1 unit. GEANAKOPLOS.

306. **The Age of the Protestant and Catholic Reformation, 1500 to 1648.** II; ½ to 1 unit.

307. **Classical Islam: The Near East from Mohammed to the Crusades.** I; ½ to 1 unit. DAWN.

308. **The Europeanization of the Near East, 1768 to 1914.** II; ½ to 1 unit. DAWN.

309. **Development of Modern Europe: Absolutism and Colonial Expansion, 1648 to 1789.** I; ½ to 1 unit. SIRICH.

310. **Development of Modern Europe: The French Revolution and Napoleon, 1789 to 1815.** II; ½ to 1 unit. SIRICH.

311. **European History from 1815 to 1871.** I; ½ to 1 unit. PFLANZE.

312. **European History from 1871 to 1900.** II; ½ to 1 unit. PFLANZE.

313. **European History from 1900 to 1929.** I; ½ to 1 unit. SHAY.

314. **European History from 1929 to the Present.** II; ½ to 1 unit. SHAY.

322. **History of Spain and Portugal.** A survey of the Iberian Peninsula from the earliest times until the present. I; ½ to 1 unit. NOWELL.

323. **Science, Philosophy, and the Modern European Mind.** Intellectual history of modern Europe from 1543 to 1770. I; ½ to 1 unit. SIRICH, STEARNS.

324. **Science, Idealism, and Materialism.** Intellectual history of modern Europe from 1770 to 1914. II; ½ to 1 unit. SIRICH, STEARNS.

326. **Intellectual and Cultural History of Russia from 1881 to the Present.** II; ½ to 1 unit. FISHER.

327. **The Russian Revolution.** I; ½ to 1 unit. FISHER.

328. **History of Soviet Russia from 1917 to the Present.** II; ½ to 1 unit. FISHER.

333. **Great Britain under the Tudors and Stuarts, 1485 to 1688.** This course traces the principal political, economic, social, religious, and cultural developments in British history, including Scotland and Ireland, from the beginning of the Tudor dynasty to the Glorious Revolution of 1688. I; ½ to 1 unit. LEE.

337. **Economic History of American Agriculture.** Same as Agricultural Economics 337 and Economics 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. Graduate students who take this course for one unit credit are required to do extra work. The student writes a scholarly paper on some approved topic in agricultural history. I; ½ or 1 unit. Prerequisite: A college level course in basic economics or American history. JONES.

339. **History of the British Commonwealth in the Nineteenth Century, 1783 to 1900.** I; ½ to 1 unit. ERICKSON.

340. **History of the British Commonwealth in the Twentieth Century, 1901 to the Present.** II; ½ to 1 unit. ERICKSON.

341. **Modern Britain, The Victorian Era, 1815 to 1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. I; ½ to 1 unit. Offered in 1961-1962 and in alternate years. ERICKSON.

342. **Modern Britain Since 1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. II; ½ to 1 unit. Offered in 1961-1962 and in alternate years. ERICKSON.

345. **Constitutional History of England to 1485.** I; ½ to 1 unit. LEE.

346. **Constitutional History of England from 1485 to the Present.** II; ½ to 1 unit. LEE.

352. **Colonial Beginnings of American Life and Institutions.** A study of the seventeenth- and eighteenth-century colonies. I; ½ to 1 unit. DUNBAR.

354. **The Era of the American Revolution, 1763 to 1789.** II; ½ to 1 unit. DUNBAR.

356. **History of the United States from Jackson to the Civil War.** Study of Jacksonian democracy; the rise of sectionalism; manifest destiny and the Mexican War; the issue of slavery and expansion and the approach of the Civil War. I; ½ to 1 unit. JOHANNSEN.

357. **Social and Economic History of the United States from 1775 to 1860.** The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. I; ½ to 1 unit. SHANNON.

358. **Social and Economic History of the United States Since 1860.** The growth of American economic life and institutions since 1860. II; ½ to 1 unit. SHANNON.

359. **The Civil War and Reconstruction.** Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. I; ½ to 1 unit. SHANNON.

361. **History of the United States from 1877 to 1917.** I; ½ to 1 unit. BATES.

2. **History of the United States Since 1917.** II; ½ to 1 unit. BATES.

3. **History of the West, 1634 to 1774.** French colonization of North America. I; ½ unit.

4. **History of the West, 1774 to 1830.** The American frontier. II; ½ unit.

5. **The History of Illinois to 1870.** Evolution of a typical midwestern commonwealth, with emphasis upon its political, economic, social, religious, and cultural development in the nineteenth century. I; ½ unit. SUTTON.

6. **The History of Illinois from 1870 to the Present.** The evolution of a modern American state, with emphasis upon its political life, economic growth, social and intellectual problems, and its contribution to the American nation. II; ½ unit. SUTTON.

7. **The Trans-Mississippi West.** The history of Western expansion since the Louisiana Purchase; the West in the general history of the United States; Western economic and political problems. II; ½ to 1 unit. JOHANNSEN.

8. **History of the South.** An inquiry into the question, when did the South begin and what have been its distinguishing traits? Special attention is given to agrarianism, industrialization, and the race problem. II; ½ to 1 unit. BATES.

69. **Constitutional Development of the United States to 1865.** I; ½ to 1 unit. BESTOR.

70. **Constitutional Development of the United States Since 1865.** II; ½ to 1 unit. BESTOR.

71. **American Intellectual and Cultural History to 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. I or II; ½ to 1 unit. BESTOR.

72. **American Intellectual and Cultural History Since 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. I or II; ½ to 1 unit. BESTOR.

73. **Diplomatic History of the United States to the End of the Nineteenth Century.** I; ½ to 1 unit. GRAEBNER.

74. **Diplomatic History of the United States in the Twentieth Century.** II; ½ to 1 unit. GRAEBNER.

75. **History of Latin America to 1824.** A survey of Latin-American history from the discovery of America until 1824. I; ½ to 1 unit. NOWELL.

76. **Latin America Since 1824.** A history of the Latin-American republics from their independence to the present. II; ½ to 1 unit. NOWELL.

77. **History of the A.B.C. Powers.** History of Argentina, Brazil, and Chile from their origins to the present. I; ½ to 1 unit. NOWELL.

78. **History of the Caribbean Area.** A survey of the Caribbean, Mexico, and Central America from the discovery of America to the present. II; ½ to 1 unit. NOWELL.

381. **Ancient Greek States.** History of the Greek states from the earliest times to 334 B.C. I or II; ½ to 1 unit. STARR.

382. **Alexander and His Successors.** II; ½ to 1 unit. STARR.

383. **History of the Roman Republic to 44 B.C.** I; ½ to 1 unit. STARR.

384. **The Roman Empire.** II; ½ to 1 unit. STARR.

391. **History of Eastern Asia to 1839.** History of eastern Asia (China, Japan, and India) to 1839. I; ½ unit.

392. **History of Eastern Asia Since 1839.** History of eastern Asia (China, Japan, and India) since 1839. II; ½ unit.

HOME ECONOMICS

The Department of Home Economics offers graduate work leading to the degrees of Master of Science or Master of Arts in Home Economics; Master of Science in Home Economics Education; and Doctor of Philosophy in Home Economics with a major in foods and nutrition. The major work for a master's degree in home economics may be done in one of five curricula: child development and family relationships, family housing and household management, foods and nutrition, general home economics, or textiles and clothing. The minimum grade-point average for admission to graduate study in home economics and home economics education is 3.5.

Degree of Master of Science or Master of Arts. Students who elect home economics as the major subject for a master's degree should have complied with the undergraduate requirements of the field of concentration selected or should have had equivalent training. Students from allied fields are admitted; however, they are expected to make up courses prerequisite to those listed in the curriculum chosen for study.

All candidates for a master's degree in home economics must take a minimum of eight units or nine units if a thesis is not submitted. In either case at least four units are in home economics. Four units, at least two in home economics, must be courses numbered 400 or above.

Recommended home economics courses, suggested electives, and special requirements for each of the five curricula are as follows:

(1) *Child Development and Family Relationships.* A minimum of four units from Home Economics 301, 305, 410, 418, 419, and 499. The additional units may be selected from other home economics courses and from courses in such related fields as anthropology, education, library science, psychology, social work, sociology, and speech.

(2) *Family Housing and Household Management.* A minimum of two units from Home Economics 361, 375, 378, and 379, Agricultural Engineering 300, and Architecture 339; three units from Home Economics 380, 410, 418, 419, 480, 487, and 493; two units from City Planning 372, Finance 313, 369, Sociology 407, 476, 477; and additional courses to total nine units selected from other home economics courses and from courses in such related fields as anthropology, architecture, economics, education, psychology, and sociology.

(3) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 422, 423, 430, 432, and 499. Additional units may be selected from a list of suggested courses in animal nutrition, chemistry, food technology, home economics, microbiology, and physiology. Chemistry 354 or 350 and 355 are required.

(4) *General Home Economics.* A minimum of four units from prescribed courses in three of the following curricula: (1), (2), (3), or (5). Additional units may be taken in other home economics courses and such other related fields as economics, education, psychology, or sociology.

(5) *Textiles and Clothing.* A minimum of four units from Home Economics 375, 380, 386, 388, 395, 480, 487, and 499. Additional units may be taken in other home economics courses and such related fields as art, chemistry, economics, education, marketing, psychology, and sociology.

A list of suggested electives in each of the above curricula is available from the department upon request.

Candidates for the degree of Master of Science in Home Economics Education must earn eight units with four in home economics. Three units must be in 400-numbered courses and at least one of these three must be in home economics. Courses in home economics are to be chosen from Home Economics 361, 375, 378, 379, 320, 322, 323, 326, 330, 331, 380, 386, 388, 395, 480, 487, 301, 410,

418, and 419; Education 311 and 312, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; Education 453, one unit; Education 456, one unit, or Home Economics 377, one-half to one unit. The elective courses must be selected with the approval of the advisers, Professor Janice M. Smith, head of the Department of Home Economics, 260 Bevier Hall, and Professor Letitia Walsh, 334 Gregory Hall.

Degree of Doctor of Philosophy. Candidates for this degree with a major in foods and nutrition should have had an undergraduate foods course with an organic chemistry prerequisite; a nutrition course with organic chemistry and physiology prerequisites; adequate training in chemistry, including quantitative analysis and organic; and introductory courses in microbiology, physics, and trigonometry. Furthermore, a student emphasizing foods in the Ph.D. program should have had a course in colloid chemistry. Deficiencies in these requirements may be made up during the first year of graduate study.

Programs for the degree are planned by the candidates in consultation with departmental advisers taking into account the Graduate College requirements for residence, languages, minors, preliminary and final examinations, and thesis. Required courses include at least three units of foods and nutrition, two at the 400 level; one unit of statistical methods at the 400 level; courses in biochemistry and physical chemistry; and an advanced course in food microbiology or mammalian physiology. Additional courses in the above areas or in animal nutrition or food technology are selected to satisfy major unit requirements. Candidates may elect to minor in animal nutrition, biochemistry, food technology, microbiology, physiology, and other appropriate areas. Either foods or nutrition is emphasized in research for the thesis.

Graduate students who choose an area of home economics as a minor for the degree of Doctor of Philosophy should have adequate preparation in the area and must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in courses numbered above 400.

GRADUATE TEACHING FACULTY

Professors: Janice M. Smith (Head of Department), E. W. Anderson, Julia O. Holmes, Frances Van Duyne, Letitia Walsh.

Associate Professors: Harriet T. Barto, Mildred Bonnell, Ruth L. Galbraith, Margaret Goodyear, Pearl Janssen, Helen E. McCullough, Queenie B. Mills, Elizabeth M. Osman, Lorraine D. Trebilcock, Jane E. Werden.

Assistant Professors: Karlyne Anspach, Beulah Hunzicker, W. C. Kauffman, Beula V. McKey.

Instructor: Eloise Lorch.

COURSES FOR GRADUATES

410. **Problems in Family Living.** Family relationships and their significance to the growth of family members. II; 1 unit. Prerequisite: Home Economics 210.

418. **Seminar in Child Development.** Advanced problems in child development. II; 1 unit. Prerequisite: Home Economics 301.

419. **Seminar in Family Relationships.** Special problems in family living. II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Home Economics 410.

422. **Seminar in Nutrition.** A study of recent literature in nutrition. I; ½ to 1 unit. Prerequisite: Graduate standing and undergraduate degree in home

economics, with emphasis on foods and nutrition or comparable background in biochemistry, microbiology, physiology, or other biological science. HOLMES.

423. **Problems in Human Nutrition.** Methods of assessing nutritional status of humans. II; ½ to 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Home Economics 324 or equivalent. HOLMES.

430. **Carbohydrates in Foods.** Same as Food Technology 430. A study of the physical and chemical properties of carbohydrates used in food and their behavior under conditions encountered in food processing and storage. I; ¾ unit. Prerequisite: Chemistry 354 or 350 and 355, or consent of instructor. OSMAN.

432. **Seminar in Foods.** Review of current literature in foods research. II; ½ to 1 unit. Prerequisite: Undergraduate curriculum with major in foods and nutrition or undergraduate majors in chemistry, microbiology, or physiology if certain undergraduate courses in foods and nutrition are included. VAN DUYNE.

480. **Seminar in Textiles.** Current literature related to development in the production, use, and care of textile fabrics. II; ½ to 1 unit. Prerequisite: Home Economics 380 or equivalent; consent of instructor. GALBRAITH.

487. **Seminar in Clothing.** Study and discussion of research in clothing from the aspects of psychological and sociological factors contributing to the effect of clothing on the development of individuals and on family and community group reactions. I; ½ to 1 unit. Prerequisite: Undergraduate curriculum with majors in textiles and clothing, home economics education, home economics extension, or general home economics. ANSPACH.

493. **Advanced Studies in Home Economics.** Library or experimental research on specific problems of limited scope. Work may be taken in the following subjects: (a) child and family, (b) family housing, (c) foods, (d) nutrition, (e) textiles and clothing. This is one of the courses which may be taken in addition to eight units required for a master's degree by students who do not write a thesis. I, II; ½ to 1 unit. STAFF.

499. **Thesis Research.** Work may be taken in the following subjects: (a) the child and the family, (b) family housing, (c) foods, (d) nutrition, (e) textiles and clothing. I, II; 0 to 4 units. GALBRAITH, HOLMES, OSMAN, SMITH, VAN DUYNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Problems in Home Guidance of Children.** Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. I and II; ½ to 1 unit. Prerequisite: Home Economics 202 and 203; consent of instructor. MILLS.

305. **Human Heredity.** Heredity in man and its relation to various individual and social problems. Lectures, discussions, and demonstrations. Graduate credit does not count toward a major in genetics. I; ½ unit.

320. **Diet in Disease.** II; ½ unit. Prerequisite: Home Economics 220. BARTO.

322. **Physical Growth and Nutrition.** Lectures, readings, and discussions. I; ½ unit. Prerequisite: Home Economics 220; consent of instructor. HOLMES.

323. **Recent Advances in Foods and Nutrition.** New developments in foods and nutrition through readings, lectures, and discussions. S; ½ unit. Prerequisite: Chemistry 132 or 133; Physiology 103; Home Economics 220 and 231. HOLMES, MCKEY, VAN DUYNE.

324. **Problems in Nutrition.** Discussions and investigations. I or II; ½ to 1 unit. Prerequisite: Home Economics 220; Chemistry 354 or 350 and 355; senior standing. HOLMES, MCKEY.

326. **Demonstration Problems and Techniques.** Consideration of the techniques of demonstrations and problems involved. II; ½ unit. Prerequisite: One of the following: Home Economics 231, 262, 270, 301, 375, 379, 380, 386; or consent of instructor. JANSSEN.

330. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. I, II; ½ unit. Prerequisite: Home Economics 231; Microbiology 100 and 101. JANSSEN.

331. **Problems in Foods.** Individual problems in food preparation and preservation. II; ½ unit. Prerequisite: Home Economics 330. VAN DUYNE.

345. **Institution Management.** Purchase of food supplies and equipment for institutions; grades of food, judging of quality and cost in relation to season, pure food laws and government inspection; the storeroom and its management; equipment and furnishing; floor plans and routing; specifications for equipment; inventory of equipment; visits to stores and markets. I; ½ unit. Prerequisite: Credit or registration in Home Economics 240 and Economics 108; consent of instructor. BONNELL.

350. **Institution Organization and Management.** Organization and menu making for various types of institutions such as residence halls, cafeterias, and hospitals; personnel management and labor problems; records and cost accounting; professional ethics. Opportunity is given for observation and practice in various fields. Field trip required; estimated expense, $50.00. II; ½ to 1 unit. Prerequisite: Home Economics 220 and 240; consent of instructor. HUNZICKER.

351. **Special Problems on Group Feeding with Emphasis on the School Lunch.** Planned for teachers in secondary schools and for home advisers and others interested in community feeding problems. Lectures, discussions, and laboratory practice in quantity food management. Emphasis is on the school lunch program as an integral part of the educational system. Special problems in purchasing, floor plans, and equipment are required of graduate students. No credit is given to students who have had Home Economics 350. S; ½ unit. Prerequisite: Home Economics 220, 231, or equivalent; consent of instructor. Food handler's certificate required. BONNELL.

355. **Advanced Quantity Cookery and Catering.** Planned for students in the restaurant management curriculum and for other qualified students. Practice in menu making and aspects of management necessary for special catering functions and meal projects; special lectures and demonstrations emphasizing the artistry of preparation, serving, and merchandising of quality food; supervised practice in various food service units. Field trips and special assignments. II; ½ unit. Prerequisite: Home Economics 350; consent of instructor. BONNELL.

361. **Development and Function of Family Housing.** Same as Agricultural Engineering 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. II; ½ unit. Prerequisite: Home Economics 160, 171, or consent of instructor. HINCHCLIFF.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment and equipment performance tests. I, II; ½ unit. Prerequisite: Home

Economics 171; six advanced hours in home economics; including one of the following: Home Economics 231, 273, 380; consent of instructor. LORCH.

377. **Home Economics Extension.** History and development; types of county organizations; objectives; extension teaching tools; county program determination and evaluation. Field trips. II; ½ to 1 unit. Prerequisite: Consent of instructor. ANDERSON.

378. **Problems in Home Management.** Individual investigation and reports of specific problems in the field of home management. I; ½ unit. Prerequisite: Home Economics 270 or 273; consent of instructor. GOODYEAR, MCCULLOUGH.

379. **Problems in Home Management.** Individual investigation and reports of specific problems in the field of home management. II; ½ unit. Prerequisite: Home Economics 270 or 273; consent of instructor. GOODYEAR, MCCULLOUGH.

380. **Textiles.** Textiles from the economic, artistic, physical, and chemical viewpoints. I; 1 unit. Prerequisite: Home Economics 183; Chemistry 132; Economics 108; senior standing; consent of instructor. GALBRAITH.

386. **Clothing Design: Draping.** Designing by draping, inspired by appropriate design sources; understanding of fitting principles through fabric manipulations; design effects maintained in garment construction. I, II; 1 unit. Prerequisite: Home Economics 285 and 286. ANSPACH.

388. **Problems in Textiles and Clothing.** Investigation and report of specific problems in the field of textiles and clothing. I; ½ to 1 unit. Prerequisite: Home Economics 286 or 380; consent of instructor. Each student undertakes an individual problem which in some cases may involve prerequisites in chemistry and physics. GALBRAITH, TREBILCOCK, WERDEN.

395. **Fashion Analysis.** A study of fashion terminology, selected designers, garment manufacturing techniques, and methods of fashion promotion used in retail outlets. Field trip; estimated expense, $10.00. II; ½ unit. Prerequisite: Marketing 281 or Journalism 281; senior standing; consent of instructor. TREBILCOCK.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy degrees. Candidates may specialize for either degree in floriculture, plant breeding, pomology, or vegetable crops.

The minimum grade-point average for admission to graduate study in horticulture is 3.5.

Twenty hours of undergraduate work in horticulture and allied subjects are required of students who choose horticulture as a major, and twelve hours are required of those who select it as a minor. The department waives certain of these requirements for some fields of major study if the student has had an equivalent preparation in the fundamental sciences. It is desirable, when the major field of study is decided upon during the junior or senior year, to select the fundamental science courses accordingly and, if possible, to include in the undergraduate preparation the elementary courses in German or French.

Advanced work in agricultural economics, agronomy, botany, chemistry, entomology, genetics, or plant pathology may be taken advantageously with horticulture to make a well-balanced course of graduate study.

GRADUATE TEACHING FACULTY

Professors: C. J. BIRKELAND (Head of Department), R. V. LOTT, V. G. MILUM, F. WEINARD.

Associate Professors: C. Y. Arnold, J. R. Culbert, D. F. Dayton, J. R. Kamp, J. P. McCollum, R. K. Simons, A. E. Thompson, J. S. Titus.

COURSES FOR GRADUATES

424. **Mineral Nutrition of Plants.** Same as Agronomy 424 and Botany 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. II; 1 unit. Prerequisite: Botany 130 or consent of instructor. Hageman.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy 440, Animal Science 440, Dairy Science 440, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. Jacob.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy 441, Animal Science 441, Dairy Science 441, and Veterinary Medical Science 441. A continuation of Horticulture 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Horticulture 440 or equivalent. Jacob.

447. **Horticulture Seminar.** Discussion of current research and literature pertaining to problems of horticulture and related fields. I, II; ¼ unit. Staff.

490. **Research Methods in Horticulture.** Lectures, discussions, demonstrations, and laboratory exercises dealing with methods and apparatus used in horticultural research. II; 1 unit. Prerequisite: Chemistry 133 or equivalent; Chemistry 122 or equivalent; Botany 130; five hours of physics. Staff.

492. **Special Topics in Horticulture.** Readings and discussions in selected phases of horticulture including such topics as genetics, physiology, anatomy, morphology, and ecology of horticultural crops. I, II; ½ to 2 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

499. **Thesis Research.** Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. I, II; 0 to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Fruit Diseases.** Same as Plant Pathology 307. Symptomatology, life cycles, control measures; laboratory and field studies of representative diseases. II; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Plant Pathology 301 or Botany 372; consent of instructor. Powell.

308. **Vegetable and Canning Crop Diseases.** Same as Plant Pathology 308. Symptomatology, etiology, epiphytology, and control measures; laboratory and field studies of representative diseases. I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Plant Pathology or Botany 372. Linn.

321. **Floricultural Physiology.** Plant hormones, light, temperature, humidity, and gases on growth of ornamental plants; principles of disease and insect control. Lectures, assigned readings, discussion. I; ½ unit. Prerequisite: Botany 130. Weinard.

322. **Plant Nutrition.** Soil conditions in relation to the growth of ornamental plants; soil and plant tissue tests, fertilizers and their use; soilless culture; water supplies and automatic watering. Lectures, assigned readings, discussions. II; ½ unit. Prerequisite: Botany 130; Agronomy 201. WEINARD.

335. **Economics of Food Distribution.** Same as Agricultural Economics 335 and Marketing 335. Analysis of (a) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (b) effects of industry organization and government regulations on marketing functions and efficiency; (c) consumer demand for food. I; ½ unit. Prerequisite: Agricultural Economics 230 or equivalent; Economics 109. KELLY.

345. **Growth and Development of Horticultural Crops.** Factors affecting growth, development, and quality of vegetable crops. Lecture and discussion. I; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Botany 130 or consent of instructor. MCCOLLUM.

363. **Advanced Pomology.** The development and performance of fruit plants as influenced by environment and production practices. Discussion, lectures, and laboratory. Three-day field trip; transportation furnished. I; 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Horticulture 262, Botany 130, and Agronomy 201, or consent of instructor. SIMONS, TITUS.

365. **Systematic Horticulture.** The origin, history, and taxonomic nomenclature of the principal fruit, vegetable, and ornamental plants of the world; relationships among horticultural plants based on cytology and reproduction; the nature and extent of variability in economic horticultural species. I; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Botany 160 or equivalent; consent of instructor. DAYTON.

382. **Improvement of Horticultural Crops by Breeding.** Mechanism of hereditary variations and varietal differentiation in horticultural plants as a basis for determining the method of approach to crop improvement problems, with emphasis on asexually propagated crops. II; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Horticulture 110 or equivalent. THOMPSON.

HUMANITIES

The Division of Humanities is an organization representing the Departments of Classics, English, French, German, History, Philosophy, Russian, Spanish and Italian, and Speech. It sponsors courses of interdepartmental interest and purpose.

COURSES FOR GRADUATES

402. **Field Methods in Linguistics.** The recording and analysis of a spoken language with a native speaker of that language as informant. I or II; ½ to 1 unit. Prerequisite: Humanities 300, 301, and 302, or consent of instructor. MACLAY.

411. **Methods in Historical Linguistics.** Advanced analysis of genetic comparison and reconstruction, linguistic borrowing, linguistic geography, etymology, and related topics. I or II; 1 unit. Prerequisite: Humanities 302 or Anthropology 370.

412. **Research Seminar in Historical Linguistics.** Research work in etymology, linguistic geography, and historical syntax. I or II; 1 unit. Prerequisite: Humanities 411. KAHANE.

424. **Linguistics and Communication.** The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. I; 1 unit. MACLAY.

25. **Psycholinguistics.** Same as Communications 425 and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. I or II; 1 unit. Prerequisite: Consent of instructor. OSGOOD.

26. **Research Seminar in Psycholinguistics.** Same as Communications 426 and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. I or II; ½ to 1 unit. Prerequisite: Humanities 425; consent of instructor. MACLAY, OSGOOD.

73. **Seminar in Phonetics.** Same as Communications 442 and Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. I or II; 1 unit. Prerequisite: Consent of instructor. HULTZÉN.

75. **Experimental Phonetics, I.** Same as Communications 475 and Speech 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. I; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

76. **Experimental Phonetics, II.** Same as Communications 476 and Speech 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. II; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

77. **Measurement of Speech, I.** Same as Speech 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. I; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. FAIRBANKS.

78. **Measurement of Speech, II.** Same as Speech 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. II; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. FAIRBANKS.

79. **Seminar in Experimental Phonetics.** Same as Communications 479 and Speech 479. Advanced consideration of experimental research in the physiological, acoustical, and psychophysical aspects of speech and hearing. Extensive survey of current literature. S; 1 unit. Prerequisite: Speech 475 and 476, or consent of instructor. FAIRBANKS.

90. **Special Topics in Linguistics.** Individual studies in the areas of linguistics, not covered by the regular course offerings. I, II; ½ to 2 units. STAFF.

99. **Thesis Research.** I, II; 0 to 4 units.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

00. **Introduction to Linguistics.** An introduction to the science of descriptive linquistics. I; ½ to 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

01. **Introduction to Phonetics.** Same as Speech 301. Basic principles of phonetic

study, including observation and representation of pronunciations; ear training; practice in transcription. I, II; ½ to 1 unit. HULTZÉN, MUELLER.

302. **Comparative Linguistics.** Same as Communications 302. An introduction to the historical aspects of language. II; ½ to 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

303. **Morphemics and Syntax.** The techniques and assumptions of morphemic analysis; isolation of morphemes; recognition of form classes; description of syntactic patterns. I, II; ½ unit. Prerequisite: Humanities 300 (formerly 301) or consent of instructor.

370. **Language, Culture, and Society.** Same as Anthropology 370. An examination of the social and cultural functions of language with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. I or II; ½ to 1 unit. MACLAY.

373. **Phonetics and Phonemics.** Same as Communications 373 and Speech 373. Methodologies of phonetics, with special application to English; general principles of phonemic interpretation. I or II; ½ to 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Speech 301. HULTZÉN.

387. **The Structure of English.** Same as English 387. A consideration of the role of linguistics in writing and evaluating grammars, and of the formal properties of various grammars; detailed treatment of a generative grammar of English containing phrasal, transformational, and morphophonemic levels. I or II; ¾ unit. SLEATOR.

388. **Linguistics in Language Learning.** Same as Rhetoric 388. The application of linguistic methods to the learning of a second language, with special emphasis on the learning of English. I or II; ¾ unit. SLEATOR.

JOURNALISM

The Department of Journalism offers graduate work leading to the degree of Master of Science in Journalism. For the program leading to the Doctor of Philosophy degree in Communications, see page 105.

Admission to graduate work in journalism requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in journalism or a related field, English, or the social sciences; and (2) a grade-point average of at least 3.75.

Requirements for the master's degree include:

(1) A major of four units or three units and one additional unit approved by the adviser. Candidates must select at least two units from Journalism 471, 473, and 474. Candidates without acceptable undergraduate majors are required to complete Journalism 311, 321, and 323.

(2) A minor of at least two units, normally in an area outside the College of Journalism and Communications.

(3) A thesis of one or two units.

(4) A minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

GRADUATE TEACHING FACULTY

Professors: R. R. BARLOW, L. W. MURPHY, T. B. PETERSON.

Associate Professors: J. W. JENSEN (Head of Department), D. E. BROWN, G. GERBNER, J. C. SUTTON.

Assistant Professors: G. G. Hanson, H. S. Maclay, J. H. Schacht, A. E. Strang.

COURSES FOR GRADUATES

467. **The Political Economy of Communications, I.** Same as Communications 467. Analysis of theory and problems concerning such social agencies of communication as newspapers, magazines, books, postal service, and telegraph, with special emphasis on their policies and structures. I; 1 unit. Prerequisite: Economics 102 and 103, or 108, or consent of instructor. Smythe.

468. **The Political Economy of Communications, II.** Same as Communications 468. Analysis of theory and problems concerning such social agencies of communication as telephone, radio services (including television), and motion pictures, with special emphasis on their policies and structures. II; 1 unit. Prerequisite: Journalism 467. Smythe.

470. **Communications and Popular Culture.** Same as Communications 470. Problems of cultural analysis related to the media of communications; social implications of communications research. II; 1 unit. Gerbner.

471. **Proseminar in Communications, I.** Same as Communications 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. I; 1 unit. Smythe and others.

472. **Proseminar in Communications, II.** Same as Communications 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. II; 1 unit. Maclay and others.

473. **History and Theory of Freedom of the Press.** Same as Communications 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. I; 1 unit. Jensen.

474. **Government and Mass Communications.** Same as Communications 474. Communications and political order; theory and structure of democratic and totalitarian communications systems; relationship between government and mass communications in the modern world. II; 1 unit. Jensen.

490. **Special Topics in Journalism.** I, II; ½ to 1 unit. Prerequisite: Consent of head of department. Staff.

499. **Thesis Research.** I, II; 1 to 2 units. Prerequisite: Graduate standing in journalism. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **High School Journalism.** Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. II; ½ unit. Prerequisite: Education 211 or consent of instructor. Brown.

309. **Public Relations.** Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. I; ½ unit. Murphy.

311. **Law and the Press.** The historical background of the nature and meaning of the law as it relates to journalism and contemporary problems of freedom of expression. I; ½ unit.

320. **Editorial Studies and Writing.** Writing of editorials and preparation of

editorial judgments. Policies for editorials and for the editorial page. I; ½ unit. Prerequisite: Journalism 212. BARLOW.

321. **News Editing.** Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures and makeup and design of newspaper pages. I, II; 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212. SUTTON.

323. **Advanced Reporting.** Advanced types of news investigation and treatment I, II; ½ unit. Prerequisite: Journalism 211 and 212, or equivalent. BARLOW

326. **Magazine Article Writing.** Preparation of feature stories and articles; techniques of marketing, market analysis, and selling of articles written in the course. I, II; ½ unit. SCHACHT.

327. **Special Topics in Twentieth-Century Journalism.** Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. II; ½ unit. Prerequisite: One course in college history, consent of instructor. MURPHY.

329. **Critical Writing and Reviewing.** News and comment of the stage, books, movies, and fine arts. II; ½ unit. Prerequisite: Journalism 212 or consent of instructor. MURPHY.

330. **Magazine Editing.** Basic principles of editing for consumer, business, trade, and company magazines; communications theory, market analysis, editorial process, and distribution process as they relate to magazine publishing. II; ½ unit. Prerequisite: Credit or registration in Journalism 326. SCHACHT and others.

341. **Newspaper Management.** Principles and methods in the operation of daily and weekly newspapers; managerial problems of the editorial, advertising, circulation, and commercial printing departments; plant operation. I; ½ unit. Prerequisite: Credit or registration in Journalism 204. MCCLURE.

344. **Community Newspaper Publication.** Study of weekly newspapers in handling news, editorials, features, pictures, and correspondence; and in meeting business, circulation, and advertising problems. Includes one or more field trips for each student, with actual work on a small newspaper. II; ½ unit. Prerequisite: Journalism 211. STRANG.

351. **Graphic Production Processes.** Detailed study of the preparation of copy and illustrative material for the mass production of news, features, and advertising; comparison of quality and costs of production processes; consideration of personnel, equipment, and raw materials entering into graphic production. II; ½ unit. Prerequisite: Journalism 204. HANSON.

392. **Research Methods for Press, Radio, and Television.** Same as Communications 392. An introduction to relevant research methods and practices for mass media personnel who need to use research as a tool of management and policy, order research, and interpret research. Lectures, readings, and laboratory practice. II; ½ unit.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a degree of Master of Arts in Labor and Industrial Relations. Students taking master's or Ph.D. degrees in other departments — economics, management, communications, history, sociology, psychology, or others — may arrange a minor in labor and industrial relations.

Graduate instruction is offered in trade union and management organization, in the accommodation of these organizations through the process and structure of

collective bargaining, in personnel administration and employee relations, and in the formulation of public policy. These matters are studied in the context of social, economic, and political change and analyzed with the help of theoretical and empirical formulations of economics, history, law, political science, psychology, and sociology.

Students applying for admission must have a grade-point average of at least 3.5, and they are admitted to the Institute on approval of the director. Prerequisites are a course in labor problems and a course in statistics. Students who can not meet these course prerequisites may register for graduate work but must remove the deficiency during the first semester of residency by taking the required course or courses without graduate credit. The Institute encourages but does not require its students to have substantial preparation in the social sciences.

A candidate for the Master of Arts degree in Labor and Industrial Relations has a choice of study programs. Program A requires eight units of graduate credit including one unit of research seminar in labor and industrial relations (Labor and Industrial Relations 493), a minimum of two units of thesis (Labor and Industrial Relations 499), and five units of electives. Program B requires a total of ten units including one unit of research seminar in labor and industrial relations (Labor and Industrial Relations 493), one unit of readings in labor and industrial relations (Labor and Industrial Relations 492), three units to be selected from three separate academic disciplines (one each from economics, history, political science, psychology, or sociology), and five units of electives. With the approval of his adviser, a student may include a limited number of courses in areas related to labor and industrial relations among his electives. A comprehensive oral examination is a requirement in both programs.

Full details of the Institute program are given in the bulletin, *Graduate Study for a Master of Arts Degree in Labor and Industrial Relations,* which may be obtained by writing to the Institute of Labor and Industrial Relations, 704 South Sixth Street, Champaign.

GRADUATE TEACHING FACULTY

Professors: M. Wagner (Director of Institute of Labor and Industrial Relations), W. E. Chalmers, M. Derber, M. Edelman, P. L. Garman, W. McPherson.

Associate Professors: Margaret K. Chandler, B. Karsh, S. B. Levine, H. Rosen, R. C. Wilcock.

Assistant Professors: W. H. Franke, S. Stark, H. C. Triandis.

COURSES FOR GRADUATES

418. **Seminar in Industrial Sociology.** Same as Sociology 418. Individual research in sociological interpretation of industrial organization; the orientation and motivation of the individual in industry and commerce; labor-management relations as group adjustments; the interrelations of industry and the community. I or II; 1 unit. Prerequisite: Six hours of sociology including Sociology 318, or consent of instructor. Chandler, Karsh.

420. **Formation of Public Policy.** Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. I or II; 1 unit. Hagan.

423. **Politics of Labor Law.** Same as Political Science 423. Labor's role in politics and as a pressure group; theories of labor policy formation; organization, procedures, and policy development in the administration of labor law; labor policy formation in the courts; labor's role in foreign political systems. I, II; 1 unit. Prerequisite: Consent of instructor. Edelman.

440. **Labor Economics.** Same as Economics 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. I; 1 unit. Prerequisite: Six hours of economics. McNatt.

441. **Labor Economics.** Same as Economics 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. II; 1 unit. Prerequisite: Six hours of economics. McNatt.

442. **Collective Bargaining.** Same as Economics 442. The development of a theory of the continuing interactions between union and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and the governmental process. I, II; 1 unit. Prerequisite: Consent of instructor. Chalmers.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Economics 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling; analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. I, II; 1 unit. Prerequisite: Consent of instructor. McPherson.

444. **Economics of Manpower Resources.** Same as Economics 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. I; 1 unit. Prerequisite: Six hours of economics. Parrish.

447. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. I, II; 1 unit. Prerequisite: Major in social science or consent of instructor. Garman.

448. **Problems of Personnel Management.** Same as Management 448. An examination of the organization and administration of the personnel function in management. Deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. I; 1 unit. Prerequisite: Management 248 or equivalent; consent of instructor. Planty.

449. **Problems of Personnel Management.** Same as Management 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives,

rating, employee services, and community relations. II; 1 unit. Prerequisite: Management 248, Labor and Industrial Relations 448, or equivalent. PLANTY.

450. **Management and Industrial Relations.** An analysis of the industrial relations function in management. Using case problems, research studies, and theoretical analyses, an examination is made of the development of the industrial relations function, alternate organizational approaches in dealing with employees and unions, the formation of labor relations policies, and management responsibilities in industrial relations. I, II; 1 unit. Prerequisite: Consent of instructor. WILCOCK.

490. **Individual Topics.** A student in labor and industrial relations may register for this unit with the consent of his curriculum adviser and the adviser under whom he will perform the individual study or research. Such individual work may include special study in a subject matter for which no course is available or an individual research project, including on-the-job research in industry, which is not being undertaken for a thesis. I, II; 1 unit. STAFF.

492. **Readings in Labor and Industrial Relations.** A course of individual study in which the student analyzes the classic literature in the field, reads more widely in several subject-matter areas, and writes a critical essay on one or more works in the literature. I, II; 1 unit. STAFF.

493. **Research Seminar in Labor and Industrial Relations.** Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. I, II; 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, FRANKE, LEVINE.

494. **Labor Relations in Modern Society.** An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. I or II; 1 unit. Prerequisite: Consent of instructor. DERBER.

496. **The Evolution of Labor-Management Relations in America.** Analysis and interpretation of the development of labor-management relations at the plant and industry levels from the stages of master and servant and master and journeyman in colonial times to the stage of constitutional government and industrial democracy in the present day. I, II; 1 unit. Prerequisite: Consent of instructor. DERBER.

498. **Analysis of Organizations in Industrial Relations.** An intensive analysis of organizational behavior, with the main focus upon the theory of organizations as social institutions. Concepts are drawn from the various social sciences and applied to the principal organizations concerned with industrial relations. The internal dynamics of unions, management, and government agencies are examined, with special reference to decision-making processes, and are related to the interactions among them. I, II; 1 unit. Prerequisite: Consent of instructor. LEVINE.

499. **Thesis Research.** For all students writing theses in labor and industrial relations. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

312. **Human Relations in Business.** Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. I, II; ½ or ¾ unit. DAUTEN, PLANTY.

318. **Industry and Society.** Same as Sociology 318. Sociology of industry and

problems of personal adjustment; the emergence of modern industrial and labor organizations and their impact upon community life. I, II; ½ to 1 unit. Registration for a full graduate unit requires both the approval of the instructor and substantial additional work. Prerequisite: Psychology 100; Sociology 100 or 104 and 105, or Division of General Studies 151 and 152, or consent of instructor. KARSH.

342. **Economics of Social Security.** Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. I; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108. MCNATT.

344. **The Law and Labor.** Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. II; ½ to 1 unit. Prerequisite: Economics 102 and 103, or 108; Economics 240. MCNATT.

346. **Foreign Labor Movements.** Same as Economics 346. Analysis of the history, organization, economic policies, political programs, and domestic, international, and contemporary influence of the labor movements of Great Britain, Sweden, Germany, France, Latin America, and Russia. I; ½ to 1 unit. Prerequisite: Economics 240.

347. **Labor Law.** Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; collective bargaining and labor contracts; wages and hours legislation; unemployment compensation. I or II; 1 unit. FLEMING.

357. **Psychology of Industrial Conflict.** Same as Psychology 357. An analysis of union-management behavior in terms of individual and social psychology. I, II; ½ to 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. Should not be taken by honors or graduate majors in psychology. STARK.

360. **Group Insurance and Pensions.** Same as Finance 360. A study of the problems faced by management and labor in establishing employee benefit plans for death, disability, and retirement. Actual case problems are used in the course. I; ½ to 1 unit. Prerequisite: Economics 240, Finance 260, or Management 248. MEHR.

365. **Government and Labor.** Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. I or II; ½ to 1 unit. EDELMAN.

368. **Public Personnel Administration.** Same as Political Science 368. An analysis of personnel management in government. Recruitment and selection, job and salary classification, work standards, training, and the role of labor and professional organizations in the public services are considered in the light of current theory and practice. I or II; ½ to 1 unit. PAGE.

LATIN-AMERICAN STUDIES

Graduate minors in Latin-American Studies are sponsored by the Division of Social Sciences and administered by the Latin-American Studies Committee.

Candidates for the master's degree who elect a minor in Latin-American

studies must complete Social Science 301 and one additional unit from the courses listed below. Doctoral candidates who elect a minor in this area must complete Social Science 301 and three additional units for a sole minor or two additional units for a split minor from the following courses.

These elective courses must be taken in at least two departments and are described under the departmental listings: Agricultural Economics 393, 401; Anthropology 352, 361, 380, 490; Art 318, 491; Botany 300; Economics 328, 329, 411, 490; Geography 332, 495; History 375, 376, 377, 378, 475, 476; Philosophy 319; Political Science 342, 343, 493; Portuguese 301; Social Science 301; Sociology 373; Spanish 303, 304, 431, 432, 433, 434, 435, 436.

Students in technical and professional colleges and schools of the University who seek knowledge of Latin-American affairs, culture, and languages are invited to consult with the program director of Latin-American Studies, either directly or through their advisers, in order to develop programs suited to their individual needs. Such a program may often be adopted as a special minor under existing regulations if the student so desires. These courses are of particular value to students who intend to carry on technical or professional work in the Latin-American area for the government, private business, publications, or religious organizations.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Social Science 301. Contemporary Latin-American Problems. Study of major cultural, economic, political, and related problems currently confronting Latin-American countries, analysis of background and limiting factors, principal issues, alternative considerations, formulation of proposals and solutions. Required of all majors and minors in Latin-American Studies — graduate and undergraduate. II; 1 unit. Prerequisite: Senior or graduate standing and registration in Latin-American Studies, or consent of instructor. Scott.

LAW

The College of Law offers a program of graduate work leading to the degree of Master of Laws (LL.M.) and to the degree of Doctor of the Science of Law (J.S.D.).

For admission, an applicant must have received a first degree in law from the University of Illinois or from a law school approved by the University, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws degree unless he has a grade average of 3.5 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of the Science of Law is normally required to have a grade average of 4.0 in all law work previously undertaken, and also to present evidence that he has the capacity to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Bachelor of Laws degree or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for either degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted

not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the LL.M. must secure an average of 3.5 in his graduate law courses; the candidate for the J.S.D., an average of 4.0.

Details of the programs may be obtained from the dean of the College of Law, 209 Law Building.

LIBRARY SCIENCE

The purpose of the Graduate School of Library Science is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree and the doctor's degree in library science.

Following suitable undergraduate preparation in general educational subjects as well as professional library courses, a fifth year of advanced professional study, combined with some advanced non-library studies, leads to the degree of Master of Science in Library Science. This degree represents the minimum academic preparation for professional librarianship.

Experienced librarians of marked professional capacity and promise may pursue a program of advanced study and research leading to the degree of Doctor of Philosophy in Library Science. The normal minimum period of study is two years beyond the master's degree.

Students holding bachelor's degrees from any accredited institution but without previous course work in library science are eligible for admission to the master's program upon completion of the pregraduate professional core. Normally, this may be accomplished in any regular summer session.

Students holding bachelor's degrees from any accredited four-year or five-year library school may be admitted directly to the master's program without further course work.

Degree of Master of Science. Applicants for admission to the Graduate School of Library Science must first be admitted to the Graduate College. Ordinarily applications are not considered from persons over thirty-five years of age unless they have been actively employed within recent years in library work or in teaching.

In addition to the Graduate College requirements, applicants to the Graduate School of Library Science must meet the following requirements:

(1) A reading knowledge of at least one modern foreign language. This requirement may be met either by completing at least one academic year of study at the college level or by passing a proficiency examination administered by the Graduate School of Library Science.

(2) Preprofessional study appropriate for advanced study in library science.

(3) Completion of a prescribed program of undergraduate library science courses. This requirement may be met by one of the following:

(a) Completion of at least eighteen semester hours of library science with a grade average of at least 3.75 from an institution approved by the University of Illinois Graduate School of Library Science.

(b) Completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, from the University of Illinois Graduate School of Library Science with a grade average of at least 3.75. Exemption from one or more of these courses may be secured by a satisfactory score on proficiency examinations which are offered on the day preceding the opening of registration each semester and summer session.

There is a special offering of these four courses each eight-week summer session, enabling beginning students to complete the entire preparatory sequence prior to entry into the regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program, and students are urged to plan accordingly.

(4) Evidence of ability to pursue graduate work in library science.

Each student's program of study is planned to suit his particular needs and purposes. This is done in consultation with an adviser at the time of original registration and thereafter. Students who have completed their undergraduate library science requirement in institutions other than the University of Illinois are required to complete Library Science 405, 407, 409, and 411 or 412. The general field work program is required of students lacking equivalent library experience.

Depending upon his previous training, a student may do a portion of his study outside the Graduate School of Library Science. Students thinking of careers in special libraries may find useful the varied courses available through cooperation with other departments of the University.

No thesis is required, but to insure that every candidate for a master's degree has satisfactorily demonstrated his ability to assemble, organize, and present information and ideas in acceptable written form, each student is required to prepare a formal term paper in one of his library science courses, this paper to be designated as the master's project.

At least two semesters in residence, or the equivalent, are required to attain the master's degree, apart from the preparatory courses. In this period, eight units of graduate study are to be completed. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five.

Advanced Master's Program. Students possessing a fifth-year bachelor's degree from an accredited library school are enrolled in the advanced master's program. A thesis is optional, and may, under certain circumstances and with specific approval of the Graduate College, be written *in absentia.* The course of study for an advanced student is, with the assistance of the student's adviser, individually planned. There are no specified or required library science courses and as many as four of the eight required units may be earned in courses offered in other departments of the University.

Correspondence regarding admission should be addressed to the Associate Director of the Graduate School of Library Science, from whom the detailed library science announcement and the necessary application blanks can be secured. All applications, transcripts, and other necessary papers should be filed as early as possible and not later than four weeks before the date of registration. No student should complete his plans for attending the Graduate School of Library Science until he has been notified of his admission.

Degree of Doctor of Philosophy. A student desiring to pursue a program of study and research leading to the degree of Doctor of Philosophy in Library Science must meet the customary admission requirements of the Graduate College. In addition, he must meet the following requirements of the Graduate School of Library Science:

(1) A master's degree in library science from an accredited library school or a bachelor's degree in library science from an accredited library school plus a master's degree in a subject field.

(2) A substantial period of acceptable professional library experience.

(3) Evidence of capacity for research and productive scholarship.

The normal minimum period of study required for the degree of Doctor of Philosophy is two years beyond the master's degree, during which the student is

required to devote all his working time to studies. All three years must be spent in resident graduate study at some accredited educational institution, and either the first two or the last two must be spent at the University of Illinois. The degree is conferred, however, not for residence during a certain period but for scholarly attainments and power of investigation as proved by a thesis and examinations.

Candidates for this degree must meet the general requirements of the Graduate College regarding residence, language requirements, academic program, and thesis.

GRADUATE TEACHING FACULTY

Professors: R. B. Downs (Director of Graduate School of Library Science), Thelma Eaton, Frances B. Jenkins, A. H. Lancour, D. E. Strout, A. H. Trotier, L. W. White.

Associate Professors: L. E. Bamber, H. Goldstein, W. V. Jackson, M. Alice Lohrer.

Instructor: Olive C. DeBruler.

COURSES FOR GRADUATES

402. **Studies in Reading.** Designed to acquaint students with the major areas of investigation and interest in reading. Special attention is given to studies of reading interests and habits of children, youth, and adults. Class discussions are devoted to analysis of various studies and their implications for library service and classroom teaching. II; 1 unit.

403. **Methods of Investigation.** Survey of library literature, with attention to examples of research in the library field, to elementary statistical procedures, and to the methods of investigation applicable to librarianship. Designed to prepare consumers rather than producers of research results. I; 1 unit. Jenkins.

405. **Library Administration.** Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. I; 1 unit. Goldstein.

406. **Library Service to Children and Young People.** The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young people in the public library. II; 1 unit. Lohrer.

407. **Cataloguing and Classification, I.** The theory, practice, and application of the principles of cataloguing and classification. Emphasizes subject cataloguing and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and the Library of Congress subject headings. I; 1 unit. Eaton.

408. **Cataloguing and Classification, II.** The theory, practice, and application of the principles of cataloguing and classification. Takes up the cataloguing and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloguing department. II; 1 unit. Prerequisite: Library Science 407. Eaton.

409. **Communication Roles and Responsibilities of Libraries.** Reviews briefly theories of learning and the communication process. Considers basic communication activities, problems, and research pertaining to normal library practices; the fostering of community relationships; maintaining intellectual

freedom; effective use of mass media; and application of photographic and electronic aids. I; 1 unit. GOLDSTEIN.

10. **Adult Education.** Reviews the literature, history, and present scope of adult education in the United States; introduces various patterns of community organization for adult education and identifies significant educational programs conducted by libraries. Students become familiar with adult education methods, techniques, and materials used in many types of adult education programs. II; 1 unit. GOLDSTEIN.

11. **Bibliography of the Humanities and Social Sciences.** Detailed consideration of the bibliographical and reference materials in some ten subject fields, with training and practice in their use for solving questions arising in reference service. I; 1 unit. JACKSON.

12. **Bibliography of Science and Technology.** Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. II; 1 unit. JENKINS.

24. **Government Publications.** The nature and scope of American and British government publications; the problems of organization arising from their form and from the methods of their production and distribution. II; 1 unit. JACKSON.

27. **Resources of American Libraries.** Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; spatial and financial aspects of library resources; methods of surveying library facilities; growth and use of union catalogues and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; and ways and means of developing research collections in special subject fields. I; 1 unit. JACKSON.

28. **Physical Problems of Libraries.** A study of the library's physical plant in the light of changing concepts and patterns of library service. Present-day library buildings, both new and remodeled, are analyzed and compared with each other as well as with buildings of the past. The interrelationship of staff, collections, users, and physical plant is examined in detail. Class discussion is supplemented by visits to new libraries and conferences with their staffs. II; 1 unit. Prerequisite: Library Science 405 or consent of instructor. STROUT.

30. **Advanced Bibliography.** Designed to enable the student to utilize the varied resources of a large research library. Deals with the method of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. II; 1 unit. Prerequisite: Library Science 424 or consent of instructor. JACKSON.

31. **History of Libraries.** The development of libraries from those of Nineveh to the present day. Includes the Hellenic libraries, Roman libraries, monastery libraries of the Middle Ages; the work of the great book collectors in building up collections which were turned over to national libraries; the development of the great private, academic, and tax supported libraries which survive today. I; ½ to 1 unit. EATON.

32. **History of Books and Printing.** The origin and evolution of the alphabet and of scripts; the history of manuscript books; the invention and spread of printing; the account of the production and distribution of printed books. Emphasis is placed on the relation of books to social conditions in the various periods studied. II; 1 unit. EATON.

33. **Biological Literature and Reference Work.** Introduction to use of the indexes and abstract journals serving the biological sciences and related fields.

The handling of pertinent general library aids, the preparation of scientific manuscripts, and the history of scientific societies also are considered. I, II; ¼ unit. BAMBER.

434. **Larger Units of Library Organization.** After a brief look at the "larger units" concept as manifested in other types of libraries, attention throughout the major portion of the course is centered on the public library. Library standards, the growth and development of county and regional libraries, the role of the state library, and the Library Services Act are among the topics treated in detail. Emphasis is on the theory, concept, and legal aspects, rather than on the operational detail, of larger units. II; 1 unit. Prerequisite: Library Science 405 or consent of instructor. STROUT.

436. **Development of the Library Catalogue.** The history and philosophy of classification schemes and cataloguing codes, and comparative study of present-day cataloguing practices. II; 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor. EATON.

439. **Medical Literature and Reference Work.** Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources. II; 1 unit. Prerequisite: Consent of instructor. JENKINS.

441. **History of Children's Literature.** Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. I; 1 unit. LOHRER.

COURSES FOR ADVANCED GRADUATES

450. **Advanced Studies in Librarianship.** Directed and supervised detailed investigation of selected problems. Work may be taken in the following fields for a maximum of two units in each: reference service; cataloging and classification; reading; college and university libraries; public libraries, school libraries; special libraries; subject bibliography, etc. I, II; 1 to 4 units. STAFF.

461. **Descriptive Bibliography.** An introduction to descriptive bibliography, its methods, ideals, and purposes from the time of Bradshaw and Proctor to Greg and Bowers. Not a course in descriptive cataloguing. S; 1 unit. Prerequisite: Open to advanced students from the Graduate School of Library Science and other departments of the University with consent of instructor. EATON.

462. **Education for Librarianship.** A study of the development of library education in this country and abroad. Not a course in teaching methods, but designed to provide understanding of the philosophical foundations of the several training agencies through analysis of their methods, content, character of personnel, and relationship to the profession at various times. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. LANCOUR.

463. **Current Developments in Technical Services.** An examination of changing policies and procedures in the administration of cataloguing, classification, and related areas. I; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. EATON.

464. **College and University Library Problems.** Investigation and review of administrative and educational problems in college and university libraries. II; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STROUT.

55. **Librarianship and Society.** Emphasis in this course is on the place of libraries as instruments of social thought and action in the twentieth century, as compared with the place and purpose of the library in the societies of the past. I; 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STROUT.

59. **Principles of Research Methods.** Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. I; 1 unit. Prerequisite: Knowledge of the principles of statistics; Master of Science in Library Science or consent of instructor. GOLDSTEIN.

99. **Thesis Research.** Individual study and research. I, II; 0 to 4 units. STAFF.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

01. **Literature of the Humanities and Social Sciences.** This course is designed to build a knowledge of the scope and significant characteristics of the several fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. I; 1 unit. STROUT.

02. **Literature of Science and Technology.** An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. II; 1 unit. JENKINS.

03. **Library Materials for Children.** The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, social, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard book selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. I, II; ½ to 1 unit. LOHRER.

04. **Library Materials for Adolescents.** The selection and use of library materials for the young adult in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. I, II; ½ to 1 unit. LOHRER.

06. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the acquisition, care, and library use of maps. Classes become familiar with the major cartobibliographical and related aids. II; ½ to 1 unit. WOODS.

08. **Audio-Visual Services in Libraries.** The development of audio-visual work in libraries. Students become aware of the range, types, and functions of the audio-visual materials, equipment, and services commonly provided, and of some organizational and technical problems met by specialists in the field. Laboratory sessions afford practical experience in working with many types of materials and equipment including radio and television. II; ½ unit (or 1 unit for candidates for the Master of Science in Library Science, upon approval of the instructor). STONE.

309. **Storytelling.** Fundamental principles of the art of storytelling includin techniques of adaptation and presentation for children of various ages. Cor tent and sources of materials; story cycles; methods of learning practice i storytelling; planning the story hour for the school and public libraries, fo recreational centers, for the radio, and television. Open to undergraduate and non-Graduate School of Library Science students. I; ½ unit. LOHREF

MANAGEMENT

The Department of Management offers graduate work either as a major o a minor leading to the degree of Master of Science, and as a minor for the Docto of Philosophy degree.

For admission a student should present a grade-point average of 3.75 com puted on the basis of the last sixty hours of course work. Candidates witl a grade-point average between 3.5 and 3.75 may be considered. Such student may be required to take an appropriate examination such as the Admission Tes for Graduate Study in Business (fee $10.00).

To do major work in the field of management, a student must have com pleted at least twenty hours of undergraduate work in business administration anc related subjects. To do minor work in this field, a student must have completec at least twelve hours of work in business administration and related subjects.

GRADUATE TEACHING FACULTY

Professors: S. Y. McMULLEN (Head of Department), P. M. DAUTEN, JR. M. J. MANDEVILLE, R. G. PLANTY.
Associate Professor: I. L. HECKMANN, JR.
Assistant Professor: J. A. LITTERER.

COURSES FOR GRADUATES

401. **Scientific Management.** A study of the development of modern industria management and the principles and practices employed at the present time I; 1 unit. DAUTEN, LITTERER, MANDEVILLE.

402. **Scientific Management.** A study of the development of modern industria management and the principles and practices employed at the present time II; 1 unit. DAUTEN, LITTERER.

403. **Evolution and Development of Industry.** The evolution of industry from ancient times to the present; the social, economic, and political develop ments consequent upon the change from manufacturing for personal use tc the present-day mass production industries. Consideration is given to the transition in organization for manufacture, technological changes, capital requirements, human relations, production processes, the location of industries, governmental control, and management responsibilities. I, II; 1 unit. LITTERER, MANDEVILLE.

416. **Problems in Business Policy.** Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. I, II; 1 unit. Prerequisite: Consent of instructor. MANDEVILLE, McMULLEN.

448. **Problems of Personnel Management.** Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. Deals with the relations of personnel administration to operating departments, and the scope of business and industrial per-

sonnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. I; 1 unit. Prerequisite: Management 248 or equivalent, or consent of instructor. HECKMANN, PLANTY.

449. **Problems of Personnel Management.** Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. II; 1 unit. Prerequisite: Management 248, 448, or equivalent. HECKMANN, PLANTY.

499. **Thesis Research.** I, II; 1 unit. DAUTEN, MANDEVILLE, MCMULLEN, PLANTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Management in Manufacturing.** Internal problems of production and efficient control in factories. I, II; ½ unit. Prerequisite: Consent of instructor.

311. **Administrative Policies and Organization.** Development of administrative organization and the determination of policies for the integration of major activities of a business enterprise. I, II; ½ or ¾ unit. (¾ unit is awarded on the basis of additional work.) Prerequisite: Consent of instructor. MANDEVILLE, MCMULLEN.

312. **Human Relations in Business.** Same as Labor and Industrial Relations 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. I, II; ½ or ¾ unit. (¾ unit is awarded on the basis of additional work.) DAUTEN, HECKMANN, LITTERER, PLANTY.

362. **Job, Wage, and Contract Administration.** An advanced, specialized treatment of the techniques, methods, and problems current in the wage and salary field. I, II; ½ unit. Prerequisite: Any one of the following courses or their equivalent: Psychology 145, 290, Economics 240, Management 248. HECKMANN.

MARKETING

Work may be done in the field of marketing for a major or a minor for the Master of Science degree and for a minor for the Doctor of Philosophy degree. To do major work in this field, a student must have a grade-point average of at least 3.5 and must have completed at least twenty hours of undergraduate work in marketing, management, finance, economics, business law, or accountancy, at least six hours of which must have been in the field of marketing. To do minor work in this field a student must have had at least twelve hours of work in the subjects named above, of which three must have been in marketing.

GRADUATE TEACHING FACULTY

Professors: H. W. HUEGY (Head of Department), F. H. BEACH, F. M. JONES, R. V. MITCHELL, H. G. WALES, N. WEDDING.
Associate Professors: R. D. MILLICAN, D. W. SCOTTON.
Assistant Professors: L. M. DEBOER, R. M. HILL, L. D. VOLPP.

COURSES FOR GRADUATES

401. **Marketing Principles and Problems.** Functional, commodity, and institutional methods of studying marketing with particular reference to the analysis and classifications of functions, commodities, and institutions. I, II; 1 unit. HUEGY.

402. **Marketing Methods and Problems.** Selected problems in the operation and management of market institutions. I, II; 1 unit. JONES.

407. **Prices and Price Policies.** An examination of the role of prices in our economy, and of price making under conditions of competition, monopoly, or monopolistic competition, with special emphasis on non-price competition; an examination of business pricing policies and of their acquisitive and social implications and significance. I, II; 1 unit. HUEGY.

415. **Merchandising Trends and Problems.** The literature, trends, policies, and organization problems involved in retail merchandising. I; 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor. JONES.

416. **Merchandising Policies and Problems.** The policies and problems relating to merchandise control, personnel, publicity, and promotion; recent literature and legislation. II; 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor. JONES.

421. **Analysis of Consumer Markets.** A study of consumers and their demands. I, II; 1 unit. MILLICAN.

422. **Advanced Marketing Research.** Advanced marketing research theory, literature, objectives, techniques, and problems of marketing research. II; 1 unit. Prerequisite: Marketing 321 or consent of instructor. WALES.

471. **History of Marketing.** The development of marketing organizations, problems, and methods in the United States from colonial times to the present. Wholesaling, retailing, market growth, consumer buying habits, advertising, selling, pricing, legislation, trade channels. II; 1 unit. Prerequisite: Marketing 101 or consent of instructor. JONES.

472. **Sales Campaigns.** Problems in managing the sales force. I, II; 1 unit. BEACH.

481. **Advanced Advertising Principles.** Same as Advertising 481 and Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students are not given graduate credit for both Marketing 481 and 388. II; 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Advertising 482 and Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both non-quantitative and quantitative methods are examined. I; 1 unit. SANDAGE.

493. **Research in Special Fields.** I, II; ¼ to 2 units.

499. **Thesis Research.** Thesis or independent study in the field of marketing. I, II; 0 to 2 units. HUEGY, JONES, and others.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Contemporary Problems in Marketing Management.** The problems which marketing managers are currently facing and an analysis of the policy decisions they must make to operate effectively. I, II; ½ unit. Prerequisite: Marketing 101. MITCHELL.

315. **Retail Buying.** Principles and procedures in buying for resale. Organization for buying, analysis of customer demand, model stock plans, sources of

supply, resident buying, cooperative and central buying, foreign buying, selection of merchandise, and trade relations. I, II; ½ unit. Prerequisite: Marketing 211. HILL.

21. **Marketing Research.** The basic techniques used in business research and specific research projects, and how their findings are used in the formulation of marketing policies. Field trip may be required; estimated expense $4.00. I, II; ½ unit. Prerequisite: Marketing 101. DEBOER.

23. **Problems in Business Research.** Selected problems in the field of commercial research. I, II; ½ to 1 unit. Prerequisite: Marketing 321. DEBOER.

25. **Sales and Distribution Cost Analysis.** Basic techniques and principles of sales and distribution cost analysis for management control of marketing activities. I, II; ½ unit. Prerequisite: Marketing 101.

31. **Grain Marketing.** Same as Agricultural Economics 331. Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially futures markets; inventory management; operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. I; ½ unit. Prerequisite: Agricultural Economics 230 or Marketing 101, or consent of instructor. HIERONYMUS.

32. **Livestock Marketing.** Same as Agricultural Economics 332 and Animal Science 332. Problems and practices in marketing livestock. Field trip; estimated expense, $7.00. II; ½ unit. Prerequisite: Agricultural Economics 230, Marketing 101, or consent of instructor. BROADBENT.

34. **Marketing Dairy Products.** Same as Agricultural Economics 334 and Dairy Science 334. The dairy industry in our national economy; factors affecting per capita consumption; price plans and policies; expanding markets; trade associations and labor unions; looking ahead in the milk business. Inspection trip; estimated expense, $5.00. II; ½ unit. Prerequisite: Agricultural Economics 230, or Marketing 101, or twelve hours of dairy science or dairy technology. BARTLETT.

35. **Economics of Food Distribution.** Same as Agricultural Economics 335 and Horticulture 335. Analysis of (a) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (b) effects of industry organization and government regulations on marketing functions and efficiency; (c) consumer demand for food. I; ½ unit. Prerequisite: Agricultural Economics 230 or equivalent; Economics 109. KELLY.

45. **Credits and Collections.** Retail and mercantile credit and collection principles and practices. I, II; ½ unit. Prerequisite: Marketing 101 or Agricultural Economics 230. SCOTTON.

49. **Trade Associations and Commercial Organizations.** Principles of trade associations and chamber of commerce organizations and management. II; ½ unit. Field trip may be required; estimated expense $5.00.

51. **Industrial Marketing.** The special problems involved in marketing materials, equipment, and supplies to manufacturers, other business firms, and institutions who use the goods in further production; determination of methods and policies appropriate to the goods and the marketing situations. I, II; ½ unit. Prerequisite: Marketing 101 or 272, or consent of instructor. HILL.

372. **Advanced Salesmanship.** An application of sales techniques to actual selling situations. Students make sales presentations, and critical appraisals are given. I, II; ¼ unit. Prerequisite: Marketing 271.

373. **Sales Management.** Modern sales organization; selling problems of manufacturers, wholesalers, and retailers; management of salesmen. I, II; ½ to 1 unit. Prerequisite: Marketing 271. BEACH.

382. **Advertising Copy and Layout.** Same as Advertising 382. Theory and practice of advertising copy writing and layout for newspaper, magazine, and direct mail; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. I, II; 1 unit. Prerequisite: Journalism 204 or consent of instructor; Marketing 281. SARGENT.

383. **Advertising Media.** Same as Advertising 383. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. I, II; ½ unit. Prerequisite: Marketing 281. MOYER.

384. **Advertising Campaigns.** Same as Advertising 384. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements — copy and layout. I, II; ½ unit. Prerequisite: Marketing 282 or 382, and 383. MOYER.

385. **Advertising Promotion and Sales.** Same as Advertising 385. Sales problems, advertising promotion, advertising research, market research. I, II; ½ unit. Prerequisite: Marketing 281. MCCLURE.

386. **Radio and Television Advertising.** Same as Advertising 386. Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. I, II; ½ unit. Prerequisite: Marketing 281. MCCLURE, SANDAGE.

387. **Advertising Policies and Problems.** Same as Advertising 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to management decision-making problems at the national level. I, II; ½ to 1 unit. Prerequisite: Marketing 281. WEDDING.

388. **Advertising in Contemporary Society.** Same as Advertising 388. A study of advertising as an institution and its role in communications, society, our economy, and business. Students are not given graduate credit for both Marketing 388 and 481. I, II; ½ unit. Prerequisite: Advertising 281 or Marketing 281, or consent of instructor. SANDAGE.

Note: See also Business Administration 373, Electronic Data Processing for Business.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the degrees of (1) Master of Arts or Master of Science in Mathematics and Doctor of Philosophy in Mathematics, (2) Master of Science in the Teaching of Mathematics and Master of Science in the Teaching of Mathematics and the Physical Sciences, and (3) Master of Arts or Master of Science in Statistics and Doctor of Philosophy in Statistics. For information concerning applied mathematics, see page 212.

MATHEMATICS

For admission a beginning graduate student must have a grade-point average of not less than 3.5.

In order to begin graduate work without deficiencies with a major in mathematics, a student should have had twenty hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and one year of more advanced work in one or more of the fields of algebra, geometry, topology, and analysis. The last requirement refers to courses equivalent to Mathematics 317-318, 327-328, 332-333, and 347-348 respectively.

The departmental requirements for the master's degree in mathematics are as follows. Of the eight units required by the Graduate College for the degree, at least six must be in mathematics, and at least three of these must be in approved courses numbered above 400. The program should include the completion of Mathematics 347-348 and at least one other basic year sequence at or above the intermediate level, normally one of the sequences 317-318, 327-328, 332-333. Since equivalents of two of these eight courses are required for admission to graduate work without deficiencies, at least half of this last requirement should ordinarily be fulfilled in previous undergraduate work. If this is not the case, two courses taken from this group of eight will merely serve to offset the deficiency and will not count toward the eight-unit total needed for the degree. A master's thesis is not required.

The departmental requirements for the Doctor of Philosophy degree are as follows. Of the sixteen units of course work required by the Graduate College before the preliminary examination, eight must be in mathematics courses at the 400 level for students with a full outside minor, and ten must be in mathematics courses at the 400 level in the case of students with one internal minor. Majors and minors within the department are chosen from the following six fields: analysis (including linear spaces, theory of probability, and analytic number theory), algebra (including group theory and mathematical logic), geometry, topology, statistics, and applied mathematics. At least two courses at the 400 level are required for an internal minor. The language requirement may be met in any two of three languages, French, German, and Russian. The Graduate College requirements concerning residence, oral examination, research units after the oral examination, thesis, and final examination must be satisfied.

The more technical courses offered by the department are arranged mainly in cycles of two or of three years, so that a properly qualified student usually has opportunity to take any particular course at some time during the three years of residence required for the doctor's degree.

Candidates for the degree of Master of Science in the Teaching of Mathematics must earn four units in mathematics, two units in education, and two units in electives. Requirements are two units from Mathematics 317, 318, 327, and 328; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The elective courses in mathematics and the other electives must be selected with the approval of the adviser. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of 3.75. The adviser for candidates for this degree is Professor H. R. Brahana, 369 Altgeld Hall.

Candidates for the degree of Master of Science in the Teaching of Mathematics and the Physical Sciences must earn two units in mathematics, three-fourths unit in chemistry, one unit in physics, two units in education, and two and one-fourth units in electives. Requirements are Mathematics 347 or 343, one unit; Mathematics 348 or 345, one unit; Chemistry 340, three-fourths unit; Physics 322, one unit; two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The electives may be in mathematics, in education, in chemistry, or in physics. Students applying for admission must have a grade-point average of 3.75. The adviser for candidates for this degree is Professor H. R. Brahana, 369 Altgeld Hall.

STATISTICS

This program of study is developed for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology.

For admission to full standing a beginning graduate student must have a grade-point average of not less than 3.5. The completion of a thorough course in calculus is also a prerequisite to admission. A course in advanced calculus, while not required, is found helpful. Students are admitted on limited status.

This program is administered by the Department of Mathematics with the help of a small interdepartmental advisory committee. The thesis for the degree of Doctor of Philosophy must show capacity for important original contributions to one or more of the following: development of new statistical ideas and methods; improvement of applications of statistical methods; and new uses of statistical methods in some field of application. The work of individual students is supervised by one adviser if the courses referred to as electives in the following are taken in general statistics; otherwise by two advisers, one representing the field of general statistics and one mathematics or a field of application.

A candidate for the degree of Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College (note the requirement of a minor of at least two units in an area of study other than statistics or mathematics), must complete the following courses: (1) Mathematics 315, 347, or equivalent; (2) eight units of statistics of which at least four must be courses at the 400 level, selected from a list of courses prepared by the Mathematics Department and including all courses in statistics listed jointly by the Mathematics Department and areas of application; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

A candidate for the degree of Master of Arts in Statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be 400 courses, selected from a list as in (2) above; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 15-22) he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

The courses required under (4) above are determined by the interests of the student. They may be taken in general statistics, in mathematics, or in an area of application. Thus, the graduate degrees in statistics permit considerable variation in the division of emphasis between general statistics and the area of application. A graduate student in statistics has two advisers, one for statistical theory, one for the area of application.

Candidates for a Doctor of Philosophy degree taking a sole minor in statistics are expected to have completed a course in calculus and are required to complete four units of work in statistics having calculus as prerequisite. Those taking a first or second minor in statistics are required to complete at least two units of work in statistics having calculus as prerequisite.

GRADUATE TEACHING FACULTY

Professors: M. M. Day (Head of Department), P. T. Bateman, C. R. Blyth, D. G. Bourgin, H. R. Brahana, S. S. Cairns, J. L. Doob, M. H.

Heins, P. W. Ketchum, J. Landin, H. Levy, C. W. Mendel, H. J. Miles, I. Reiner, M. Suzuki, A. H. Taub, W. J. Trjitzinsky, H. E. Vaughan.

Associate Professors: Beulah M. Armstrong, R. G. Bartle, W. W. Boone, W. A. Ferguson, D. B. Gillies, A. Heller, F. E. Hohn, G. E. Moore, D. E. Muller, J. W. Peters, W. J. Poppelbaum, E. J. Scott.

Assistant Professors: Felice D. Bateman, O. K. Bower, D. L. Burkholder, Josephine H. Chanler, N. T. Hamilton, Corinne R. Hattan, L. L. Helms, R. P. Jerrard, C. W. Kohls, R. M. Krause, R. G. Langebartel, G. Metze, H. A. Osborn, Echo D. Pepper, L. A. Rubel, Jewell E. Schubert, R. A. Wijsman, W. M. Zaring.

Instructor: M. Obata.

OURSES FOR GRADUATES

01. **Theory of Fields.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

02. **Linear Alegbra.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

03. **Theory of Rings.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

04. **Group Theory.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

07. **Representation Theory and Classical Groups.** I, II; 1 unit. Prerequisite: Mathematics 317 and 318, or equivalent.

08. **Lie Groups.** I, II; 1 unit. Prerequisite: Mathematics 332, 404, and 441.

14. **Logical Foundations of Mathematics.** A discussion of the logical and philosophical foundations of mathematics. I; 1 unit. Prerequisite: Philosophy 333, or Mathematics 317 or 347, or consent of instructor.

15. **Advanced Topics in the Theory of Groups.** I, II; 1 unit. Prerequisite: Consent of instructor.

16. **Advanced Topics in Abstract Algebra.** I, II; 1 unit. Prerequisite. Consent of instructor.

20. **Projective Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328.

22. **Algebraic Geometry.** I, II; 1 unit. Prerequisite: Mathematics 328.

23. **Differential Geometry.** I, II; 1 unit. Prerequisite: Mathematics 343.

27. **Foundations of Geometry.** I, II; 1 unit. Prerequisite: Consent of instructor.

28. **Topics in Geometry.** I, II; 1 unit. Prerequisite: Consent of instructor.

30. **Elementary Geometry from a Modern Viewpoint.** Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern approach. I, II; 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

31. **Number, Length, Area.** Deals with the development of the integers, rational numbers, real numbers, variables, functions, limits, area, length, volume. The principal emphasis is upon the mathematical needs of the secondary school teacher. I, II; 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

34. **Combinatorial Theory of Complexes.** I, II; 1 unit. Prerequisite: Mathematics 333.

438. **Topics in Topology.** I, II; 1 unit. Prerequisite: Consent of instructor.

439. **Seminar in Topology.** I, II; 1 unit. Prerequisite: Consent of instructor.

440. **Theory of Functions of a Complex Variable, I.** I, II; 1 unit. Prerequisite: Mathematics 348 or consent of instructor.

441. **Functions of Real Variables.** I, II; 1 unit. Prerequisite: Mathematics 347.

442. **Measure and Integration.** I, II; 1 unit. Prerequisite: Mathematics 347; consent of instructor.

444. **Partial Differential Equations.** I, II; 1 unit. Prerequisite: Consent of instructor.

445. **Theory of Functions of a Complex Variable, II.** I, II; 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. **Hilbert Space.** I, II; 1 unit. Prerequisite: Mathematics 442.

447. **Banach Spaces.** I, II; 1 unit. Prerequisite: Mathematics 442.

449. **Normed Rings.** I, II; 1 unit. Prerequisite: Mathematics 318 and 446 or 447.

451. **Theory of Probability.** I, II; 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** I, II; 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 317 and 348.

454. **Analytic Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods of Physics.** I, II; 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods of Physics.** I, II; 1 unit. Prerequisite: Mathematics 455.

457. **Analytical Problems in Numerical Analysis.** A study of the various mathematical problems arising when one formulates problems in analysis, such as the solution of ordinary or partial differential equations, for treatment by an automatic digital computer. Among the problems discussed are convergence of difference equations to differential equations, and stability of methods for approximately solving ordinary and partial differential equations. I, II; 1 unit. Prerequisite: Mathematics 387 or consent of instructor.

459. **Topics in Hydrodynamics.** I, II; 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy 424 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor. McVittie.

464. **Dynamics of the Earth's Atmosphere.** Same as Astronomy 464 and Physics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor. McVittie.

468. **Topics in Analysis.** I, II; 1 unit. Prerequisite: Consent of instructor.

469. **Seminar in Analysis.** I, II; 1 unit. Prerequisite: Consent of instructor.

470. **Statistical Decision Functions.** Statistics from the point of view of decision making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to non-sequential and sequential decision making in practice. I, II; 1 unit. Prerequisite: Consent of instructor.

2. **Econometrics.** Same as Economics 472. Application of the principles of mathematical statistics to estimation of economic relationships. II; 1 unit. Prerequisite: Mathematics 363; consent of instructor.

3. **The Theory of Testing Hypotheses.** Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. I, II; 1 unit. Prerequisite: Consent of instructor.

4. **The Theory of Estimation.** Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. I, II; 1 unit. Prerequisite: Consent of instructor.

8. **Topics in Statistics.** I, II; 1 unit. Prerequisite: Consent of instructor.

0. **Reading Course.** I, II; 1 to 2 units. Prerequisite: Consent of instructor.

3. **Proseminar.** An introduction to the methods and tools of mathematical research. The work of the course consists in the solution by the students of assigned problems in various fields of mathematics and the presentation of these solutions in both written and oral form. I, II; 1 unit. Prerequisite: Mathematics 347; credit or registration in Mathematics 348.

9. **Thesis Research.** I, II; 0 to 4 units. Prerequisite: Consent of instructor. STAFF.

OURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

1. **Fundamental Concepts of Algebra.** I, II; 1 unit. Prerequisite: One year of calculus or consent of instructor.

2. **Fundamental Concepts of Geometry.** I, II; 1 unit. Prerequisite: One year of calculus or consent of instructor.

5. **Teachers' Course.** A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry. Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic. Topics suitable for presentation for superior high school students are also considered. I, II; ½ to 1 unit. Prerequisite: One year of calculus or consent of instructor.

06. **Selected Mathematical Topics in Secondary Schools, I.** This course deals with the teaching of the following topics in secondary school mathematics: symbolism and numbers; directed numbers; variables; equations (linear, quadratic, systems); sets; graphs; bases of enumeration; functions; critical examination of these topics. I, II; ½ to 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

07. **Selected Mathematical Topics in Secondary Schools, II.** This course deals with the teaching of the following topics in high school mathematics: variables in geometry; logical analysis of geometrical propositions; equivalence relations in geometry including congruence and similarity; geometry in the coordinate plane; cosine and sine as real valued functions of real arguments; a comparison of these functions with those ordinarily taught in the high school; symmetry; periodicity; evenness and oddness; exponential and logarithmic functions. I, II; ½ to 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

11. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. I; 1 unit. Prerequisite: One year of calculus or consent of instructor.

12. **Advanced Algebra.** For students interested in actuarial science, statistics, or

teacher training in mathematics. II; 1 unit. Prerequisite: One year of calculus or consent of instructor.

315. **Linear Transformations and Matrices.** I, II; 1 unit. Prerequisite: One year of calculus.

317. **Introduction to Higher Algebra.** I; 1 unit. Prerequisite: One year of calculus.

318. **Introduction to Higher Algebra.** II; 1 unit. Prerequisite: Mathematics 317.

327. **Introduction to Higher Geometry.** I; 1 unit. Prerequisite: One year of calculus.

328. **Introduction to Higher Geometry.** II; 1 unit. Prerequisite: Mathematics 327.

332. **Topological Spaces.** I, II; 1 unit. Prerequisite: Credit or registration in Mathematics 347.

333. **Combinatorial Topology.** I, II; 1 unit. Prerequisite: Credit or registration in Mathematics 317.

341. **Differential Equations.** I, II; 1 unit. Prerequisite: One year of calculus.

342. **Differential Equations.** I, II; 1 unit. Prerequisite: Mathematics 341.

343. **Advanced Calculus.** I, II; 1 unit. Prerequisite: One year of calculus.

345. **Differential Equations and Orthogonal Functions.** I, II; 1 unit. Prerequisite: One year of calculus.

346. **Complex Variables and Applications.** For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take Mathematics 348. Credit is not given for both Mathematics 346 and 348. I, II; 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. **Introduction to Higher Analysis: Real Variables.** I, II; 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. **Introduction to Higher Analysis: Complex Variables.** I, II; 1 unit. Prerequisite: Mathematics 347.

350. **Topics in Pure Mathematics.** This is a survey course in pure mathematics for secondary school mathematics teachers. It deals with topics in number theory, topology, and analysis. I or II; 1 unit. Prerequisite: Mathematics 301; consent of instructor.

351. **Topics in Applied Mathematics.** This is a survey course in applied mathematics for secondary school mathematics teachers. It deals with topics in the application of matrices to physical and social sciences, applications of Boolean algebra, game theory. I or II; 1 unit. Prerequisite: Mathematics 301; consent of instructor.

353. **Elementary Theory of Numbers.** I, II; 1 unit. Prerequisite: One year of calculus.

354. **Elementary Theory of Numbers.** I, II; 1 unit. Prerequisite: Mathematics 317 or 353.

358. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. I, II; ½ unit. Prerequisite: Mathematics 111 or 112.

359. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. I, II; ½ unit. Prerequisite: Mathematics 358.

61. **Theory of Probability.** II; 1 unit. Prerequisite: One year of calculus.

62. **Finite Differences.** I; 1 unit. Prerequisite: One year of calculus.

63. **Advanced Statistics.** I, II; 1 unit. Prerequisite: One year of calculus.

64. **Advanced Statistics.** I, II; 1 unit. Prerequisite: Mathematics 363.

65. **Digital Computer Methods for Statistical Data Processing.** Same as Agronomy 365. A study of methods for efficient utilization of high speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Students are expected to solve problems on the computers. I; ¾ unit. Prerequisite: Mathematics 295 and a course in statistics or statistical methods or equivalent, or consent of instructor. JACOB.

71. **Actuarial Theory.** I or II; 1 unit. Prerequisite: One year of calculus. PETERS.

72. **Actuarial Theory.** I or II; 1 unit. Prerequisite: Mathematics 371.

75. **Nonparametric Inference.** Nonparametric tests of hypotheses concerning means, variances, regression, and correlation coefficients; methods depending on ranks; the efficiency of nonparametric tests. I, II; 1 unit. Prerequisite: Mathematics 361 or 363.

381. **Vector and Tensor Analysis.** I; 1 unit. Prerequisite: Mathematics 343, or equivalent, or consent of instructor.

382. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** II; 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

386. **Laplace Transforms.** I, II; 1 unit. Prerequisite: Mathematics 343.

387. **Introduction to Numerical Analysis.** I or II; 1 unit. Prerequisite: Senior standing, calculus, and a course in differential equations, or consent of instructor.

388. **Mathematical Methods in Engineering and Science.** I or II; 1 unit. Prerequisite: Mathematics 343.

391. **Boolean Algebras with Applications to Computer Circuits, I.** Same as Electrical Engineering 391. An introduction to Boolean algebra with a discussion of the elementary applications to set theory, logic, and both relay and electronic switching circuits. The Harvard chart method and other methods for circuit simplification are treated both as applied to single output and multiple output circuits. I, II; ½ to 1 unit. Prerequisite: Senior standing; consent of instructor.

392. **Boolean Algebras with Applications to Computer Circuits, II.** Same as Electrical Engineering 392. The notion of time as a parameter is introduced into the theoretical treatment of switching circuits. Examples of synthesis of time-dependent circuits are given using mathematical techniques. I, II; ½ to 1 unit. Prerequisite: Mathematics 391.

394. **Logical Design of Automatic Digital Computer Circuits.** Same as Electrical Engineering 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. I, II; 1 unit. Prerequisite: Mathematics 294 and senior standing, or consent of instructor.

395. **Advanced Programming.** This course is devoted to a discussion, by means of classroom and laboratory examples, of the efficient use of computers for solving problems. Particular emphasis is given to examples in which limitations of computers have been overcome. I, II; 1 unit. Prerequisite: Mathematics 295 and senior standing, or consent of instructor.

MATHEMATICS (APPLIED)

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, are offered by various departments in the College of Engineering and the College of Liberal Arts and Sciences. Graduate students working in applied mathematics and interested in one or more of these particular fields register in one department of the University and work for the Master of Science or the Doctor of Philosophy degree in that department.

The Committee on Applied Mathematics advises graduate students interested in one of the branches of applied mathematics listed above. Students can call on the Committee for help in planning a basic course of study which will serve as preparation for subsequent specialization and research work in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical meteorology, or the mathematical problems related to digital computer use and design. The graduate degree toward which the student is working is supervised by the department of the student's specialization.

Detailed information concerning the programs of study and research in various branches of applied mathematics may be obtained by writing to the Chairman of the Committee on Applied Mathematics, Professor A. H. Taub, Digital Computer Laboratory.

MECHANICAL AND INDUSTRIAL ENGINEERING

The Department of Mechanical and Industrial Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. Advanced study and professional training are offered in the general fields of power, design, production, and industrial engineering.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements for the degree of Bachelor of Science in mechanical engineering at the University of Illinois, with a grade-point average of at least 3.75. The applications of those with grade-point averages below 3.75, but above 3.5, are individually reviewed by the Graduate Committee and admission is granted if credentials are satisfactory. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

Except under unusual circumstances the maximum number of credits which is permitted in any course whose number ends in 8 or 9 is three units toward the requirements for a master's degree. Research work conducted in these laboratory investigations can be reported in the thesis submitted for fulfillment of the requirements for the degree. A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is required if a thesis is not included.

For further information see the booklet "Graduate Study and Research in Mechanical Engineering." Copies may be obtained from the Department of Mechanical and Industrial Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the chairman of the graduate committee, Department of Mechanical and Industrial Engineering.

ENGINEERING TEACHER-TRAINING INTERNSHIP PROGRAM

A program in engineering teacher-training is sponsored by the Ford Founda-

ion for the years 1960, 1961, and 1962. Applications for this internship program hould be sent to Professor Seichi Konzo, Coordinator of the Teaching-Internship Program, 126 Mechanical Engineering Building.

GRADUATE TEACHING FACULTY

Professors: N. A. Parker (Head of Department), E. L. Broghamer, B. T. Chao, L. E. Doyle, W. N. Espy, J. R. Fellows, G. W. Harper, W. S. Harris, E. F. Hebrank, J. A. Henry, W. L. Hull, S. Konzo, H. H. Korst, R. F. Larson, J. L. Leach, R. J. Martin, L. C. Pigage, E. I. Radzimovsky, D. G. Ryan, F. Seyfarth, S. L. Soo, K. J. Trigger.

Associate Professors: H. D. Bareither, J. R. Carroll, W. L. Chow, T. W. Price, W. F. Stoecker.

Assistant Professor: W. E. Bair.

Mechanical Engineering

COURSES FOR GRADUATES

401. **Thermodynamics and Transport Properties.** Thermodynamic and microscopic considerations for the prediction of properties. Caratheodory principle; relations between properties; microscopic description based on classical statistics; statistical equilibrium and trend toward equilibrium fluctuations; thermodynamics and transport properties; implication of wave mechanics. I; 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor. Soo.

402. **Thermodynamics and Transport Properties.** Statistical considerations based on wave mechanics; gases and relativistic modifications; radiation and high temperatures; solids and liquids; systems at low temperatures; reactive systems; electrical and magnetic properties; fluctuations and irreversible thermodynamics. II; 1 unit. Prerequisite: Mechanical Engineering 401. Soo.

403. **Advanced Combustion.** A study of the theories of combustion. Solid, liquid, and gaseous fuels as used in engineering structures. Emphasis is on experimental methods in combustion. I, II; 1 unit. Prerequisite: Undergraduate courses in thermodynamics and differential equations. Bair, Price.

404. **Gas Dynamics.** Introduction to theoretical gas dynamics; properties of compressible real fluids, fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multi-dimensional problems. I; 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. Korst.

405. **Heat Transfer.** Analysis of the methods and mechanisms of heat transfer: dimensional analysis method, design of heat exchangers, transient state heat transfer. Special problems in insulation and heat transfer. II; 1 unit. Prerequisite: Undergraduate course in heat transfer. Chao.

406. **Heat Conduction in Solids.** Fundamentals; general differential equation of heat conduction; methods of solution; steady state heat flow; transient heat flow, one and two dimensions; periodic flow of heat; internal heat source in solids. I; 1 unit. Prerequisite: Undergraduate course in heat transfer and differential equations. Chao.

407. **Selected Topics in Gas Dynamics.** Theoretical analyses of non-steady processes including scavenging, pulse jet, shock tube, and complex compressor. Includes an introduction to high velocity laboratory techniques. II; 1 unit. Prerequisite: Mechanical Engineering 404. Korst.

408. **Laboratory Investigations in Thermodynamics.** Special investigations involving thermodynamics analysis, thermodynamic properties, and performance of physical and chemical systems. I, II; ½ to 1½ units. Prerequisite: One year course in thermodynamics; one half-year course in power laboratory. BAIR, ESPY, KORST, SOO.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigations in flow, metering, heat transfer, heat exchanger performance and design. I, II; ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. BAIR, CHAO, CHOW, KORST, LARSON, PRICE.

421. **Heating and Air Conditioning.** Advanced study of heating, ventilating, and air conditioning. Factors affecting heat loss and heat gain of building, physiological effects of environment, equipment design of heat transfer equipment. Individual problems. I; 1 unit. Prerequisite: Undergraduate course in heating, ventilating, and air conditioning. BAREITHER, CARROLL, KONZO.

423. **Refrigeration Theory and Application.** Advanced study of processes and cycles; design problems; and special applications. II; 1 unit. Prerequisite: Undergraduate course in refrigeration. MARTIN, STOECKER.

428. **Laboratory Investigations in Refrigeration.** Special investigations in refrigeration. I, II; ½ to 1½ units. MARTIN, STOECKER.

429. **Laboratory Investigations in Heating and Air Conditioning.** Special investigations in heating, ventilating, and air conditioning. I, II; ½ to 1½ units. Prerequisite: Two semesters of power laboratory, or equivalent. CARROLL, HARRIS, KONZO.

432. **Theory of Rotary Compressors.** Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbo-compressors; regulation; rotary positive blowers. II; 1 unit. Prerequisite: Mechanical Engineering 205 and 206; Theoretical and Applied Mechanics 232 or Aeronautical Engineering 211 and 212. KORST.

438. **Laboratory Investigations in Power Machinery.** Special investigations in power machinery, such as turbines, engines, fans, and compressors. I, II; ½ to 1½ units. Prerequisite: One year course in power laboratory. HEBRANK, HULL.

441. **Machine Design.** A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper consideration of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. RYAN.

443. **Dynamics of Machinery.** Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, critical speeds, and vibrations in shafts; gyroscopic action in machines; flywheels, governors, and special topics. I; 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER, RYAN.

445. **Design of Internal Combustion Engines.** Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determi-

nation of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. I; 1 unit. Prerequisite: Undergraduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

48. **Laboratory Investigations in Machine Design.** Special investigations in machine design. I, II; ½ to 1½ units. BROGHAMER, RADZIMOVSKY, RYAN.

51. **Metal Cutting.** A study of the theoretical factors involved in metal cutting and forming. Basic mechanics of machining processes; friction and surface finish; temperatures developed during machining operations and the effect upon chip formation. Analysis of experimental data. Lecture and discussion periods. Survey of current literature and special topic assignments. I; 1 unit. Prerequisite: Undergraduate courses in advanced metal processing and heat treatment of metals or physical metallurgy. TRIGGER.

93. **Seminar.** Presentation and discussion of significant developments in mechanical engineering. I, II; no credit. KONZO.

99. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Thermodynamics.** Basic considerations of the three laws of thermodynamics; elementary statistical principles for the prediction of properties of pure substances and mixtures; transport properties; electric and magnetic systems. I, II; ¾ unit. Prerequisite: Mechanical Engineering 206 or equivalent; consent of instructor. SOO.

302. **Nuclear Power Engineering.** Principles of release and exploitation of nuclear energy; uranium fission and the controlled chain reaction, reactor types and design principles; radiation hazards and shielding, adaptations and economics. II; ½ to ¾ unit. LARSON.

305. **Thermodynamics of High-Velocity Flow.** The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines. I, II; ½ to ¾ unit. Prerequisite: Mechanical Engineering 206 or consent of instructor. CHOW.

309. **Experimental Gas Dynamics.** Demonstration of experimental and analytical techniques relating to compressible fluid flow inside channels. Selected studies with the water table, shock tube, small-scale supersonic wind tunnel, and blow-down tunnel. I, II; 1 unit. Prerequisite: Mechanical Engineering 305 or consent of instructor. CHOW.

311. **Instrumentation and Measurements.** Instruments and measuring equipment for flow, temperature, pressure, speed, and gas analysis. I, II; ½ to ¾ unit. KONZO.

312. **Theory of Controls.** Introduction to the theory of controls. Dynamical analysis of physical systems; steady-state operations; graphical and analytical methods of analysis; applications. I; ¾ unit. Prerequisite: Senior standing or consent of instructor.

314. **Lubrication.** The theories of lubrication; manufacture and properties of lubricants; methods of testing; lubrication methods and appliances. A study of the lubrication requirements of machines of many kinds. I; ½ to ¾ unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. RADZIMOVSKY.

322. **Heating, Ventilating, and Air Conditioning Design.** Theory and design of heating, ventilating, and air conditioning systems. I, II; ½ to ¾ unit. Prerequisite: Mechanical Engineering 252 or 260. BAREITHER, CARROLL.

332. **Theory of Internal Combustion Engineers.** Study of reciprocating engine cycles, including thermodynamics and combustion, considering such factors as fuel-air mixture, variable specific heats, chemical equilibrium and dissociation and heat losses; supercharging; flow through valves and manifolds; mixture distribution; bearings and lubrication; and effects of variables on performance. II; ½ to ¾ unit. Prerequisite: Undergraduate course in internal combustion engines. HULL.

343. **Engineering Analysis and Design.** Correlation of previously acquired design experience with the creative problems of synthesis and analysis that depend upon design judgment. I, II; ¾ unit. Prerequisite: Mechanical Engineering 271, senior standing, or consent of instructor. BROGHAMER.

347. **Analytical Study of the Principles of High-Speed Engines.** Study of the dynamics of high-speed internal-combustion engines, engine balance, crankshaft deflections, torsional vibrations. II; ½ or ¾ unit. Prerequisite: Mechanical Engineering 221 or 222; senior standing or consent of instructor. GREFFE.

Industrial Engineering

COURSES FOR GRADUATES

453. **Work Measurement.** A study of special problems of line balance, interference, and automation work loads as required to establish work standards (or production standards). I; 1 unit. Prerequisite: Industrial Engineering 332. PIGAGE.

454. **Production Engineering.** Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. II; 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

458. **Laboratory Investigations in Industrial Engineering.** Special investigations of such problems as optimization of operations, programming systems, work standards, plant layout, and flow of materials. I, II; ½ to 1½ units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

332. **Standard Time Systems.** The study of development, uses, and limitations of standard time data and predetermined time systems. II; ½ to ¾ unit. Prerequisite: Industrial Engineering 232. PIGAGE.

333. **Engineering Applications of Statistics.** Applications of statistics to engineering problems; the calculated risk in making decisions on observed data; treatment of means, percentage, and variability; control charts, acceptance sampling, linear regressions, correlation, elementary experimental design. Use of desk calculators. II; ½ to ¾ unit. Prerequisite: Mathematics 263 or 363. HENRY.

350. **Tool Engineering Analysis.** Solution of advanced problems by analytical methods with special attention to problems of dimensional planning, economics, design of tools, metal forming, and shearing tools. II; ½ to ¾ unit. Prerequisite: Industrial Engineering 282 or equivalent. DOYLE.

357. **Safety Engineering.** The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and

pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. I, II; ½ to ¾ unit. HARPER.

58. **Problems in Safety Engineering.** Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles and applications for the student interested in entering the field of safety engineering in industry. II; ½ to ¾ unit. Prerequisite: Industrial Engineering 235 or 357; consent of instructor. HARPER.

59. **Industrial Fire Protection.** Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. II; ½ to ¾ unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. HARPER.

86. **Industrial Engineering Analysis.** Analysis and development of analytical techniques for the solution of problems in industrial engineering. Application of statistical methods to uncertainty problems. Analysis of linear programming techniques appropriate to the solution of allocation problems dealing with materials, money, men, and machines. Queuing theories applied to maintenance and inventories. I; ½ to ¾ unit. Prerequisite: Mathematics 263; Industrial Engineering 286. SCHRADER.

MICROBIOLOGY

The Department of Microbiology offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. Students electing microbiology as a major for an advanced degree must have had, in addition to formal training in general bacteriology or microbiology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these course requirements may apply for admission if they have a grade-point average of at least 4.0.

Candidates for the degree of Master of Science must pass a general comprehensive examination.

MOLECULAR BIOLOGY (Biophysical Chemistry)

The Department of Microbiology in collaboration with the Department of Chemistry offers an area of specialization in biophysical chemistry. The program is flexible and provides the doctoral candidate with basic training in physical biochemistry and biology. Students electing this area should possess a solid background in physics and mathematics. Details of the curriculum are decided individually on the basis of the past experience and interests of the student. It is expected, however, that he will fulfill minor requirements in physical chemistry or biochemistry.

Courses in the Department of Microbiology directly relevant to this program are Microbiology 330, 351, 405, and 494 (same as Chemistry 494). Courses in the Department of Chemistry and Chemical Engineering especially related to this curriculum are Chemistry 346, 452, 494.

The major research areas are: (1) molecular basis of gene function; (2) structures and activities of proteins and nucleic acids; (3) intracellular organization and distribution of nucleoprotein components; (4) biosynthetic mechanisms of macromolecular replication.

GRADUATE TEACHING FACULTY

Professors: H. O. Halvorson (Head of Department), F. M. Clark, R. D DeMoss, S. Spiegelman, G. I. Wallace.
Associate Professor: R. S. Wolfe.

COURSES FOR GRADUATES

405. **Microbiological Genetics.** Study of the phenomenon of heredity in micro organisms with particular reference to recent developments in the field. Ex amples from protozoa, yeasts, molds, bacteria, and viruses are considered Emphasis is placed on critical examination and evaluation of methods. Im plications of results for fundamental aspects of gene functions are con sidered. I; ¾ unit. Prerequisite: Genetics (Botany 322 or Zoology 351) mathematics through calculus, or consent of instructor. Spiegelman.

420. **Chemistry of Microbic Processes.** The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimilation of substrates by fermentation and res piration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. II; ¾ unit. Prerequisite: Micro biology 309 or 330 and Chemistry 234 and 350, or equivalent; consent of instructor. DeMoss.

425. **Bacterial Metabolism Laboratory.** Designed to give a working knowledge of the methods currently employed in the study of the chemical aspects of microorganisms. Experiments include the analysis of fermentation mixtures the metabolic properties of microorganisms and the enzymes involved as illustrated with resting cells, cell preparations, and cell-free enzymes. The application of manometric, colorimetric, and isotopic methods to the study of microorganisms and the purification of microbic enzymes are included II; ¾ unit. Prerequisite: Credit or registration in Microbiology 420; consent of instructor. DeMoss.

451. **Experimental Virology.** Experiments to illustrate the main properties of viruses. II; ¾ unit. Prerequisite: Credit or registration in Microbiology 351; consent of instructor.

490. **Individual Problems.** I, II; ½ to 2 units. Staff.

495. **Seminar.** Required of all graduate students whose major is microbiology. I, II; 0 to ¼ unit. Prerequisite: Ten hours of microbiology; consent of instructor. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. **Cultivation and Properties of Microorganisms.** Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, cultivation of bacteria, and microbiological assays. I; 1 unit. Prerequisite: Chemistry through quantitative analysis and organic; Microbiology 101 or 201, or consent of instructor. Wolfe.

311. **Food and Industrial Microbiology.** The relationship of microorganisms to food manufacture and preservation and to industrial fermentation and processing and to sanitation. Lecture. II; ¾ unit. Prerequisite: Microbiology 101 or 201 or 309, or equivalent, and credit or registration in organic chemistry; or consent of instructor. Clark, Halvorson.

312. **Techniques of Applied Microbiology.** A consideration, through experimentation, of the properties of the bacteria, yeasts, molds, and actinomycetes which

are important to industrial processes. The methods of control of microbial processes in industry and sanitation are explored. Laboratory. II; ½ unit. Prerequisite: Credit or registration in Microbiology 311. CLARK.

326. **Pathogenic Bacteriology.** A study of the pathogenic bacteria: classification, morphology, cultural requirements, and reactions, toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lectures and laboratory. I; 1 unit. Prerequisite: Microbiology 101 or 201. WALLACE.

327. **Immunology and Serology.** A survey of the field of immunology; prevention of disease, diagnosis, and preparation and use of biologicals in the treatment of disease. Lecture and laboratory. II; 1 unit. Prerequisite: Microbiology 101 or 201. WALLACE.

330. **Advanced Microbiology.** Modern contributions to the science of microbiology, including considerations of the micro- and macro-molecular anatomy of the bacterial cell, the physiological and genetic behavior of microorganisms, and the role of bacterial viruses as agents involved in the transfer of genetic information. Lecture. I; ¾ unit. Prerequisite: Microbiology 101 or 201, or equivalent, and credit or registration in biochemistry; or consent of instructor. DEMOSS, SPIEGELMAN, WACHSMAN.

351. **Viruses.** The study of viruses as a branch of microbiology. Statistical, physical, and chemical properties of virus particles; analysis of host-virus interaction; origin and natural relations of viruses. II; ¾ unit. Prerequisite: Organic chemistry; consent of instructor.

MINING AND METALLURGICAL ENGINEERING

The Department of Mining and Metallurgical Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. The prerequisite for graduate work in metallurgical or mining engineering is the equivalent of the undergraduate courses in either of these majors which are required for the Bachelor of Science degree at the University of Illinois. A Bachelor of Science degree in some related field such as physics or chemistry is also acceptable.

A candidate for the degree of Master of Science is required to have a minimum of eight units of graduate work, including a thesis. If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. The thesis requirement is not waived for research assistants.

Students desiring to work for the degree of Doctor of Philosophy are required to pass the departmental qualifying examination. This examination must be taken no later than the end of the first semester after receiving the Master of Science degree from this department, or no later than the end of the second semester in residence, if the student has a Master of Science degree from some other department or school.

The minor requirement of the Graduate College for the degree of Doctor of Philosophy may be satisfied by taking courses in fields such as ceramics, chemistry, geology, mathematics, theoretical and applied mechanics, nuclear engineering, and physics.

GRADUATE TEACHING FACULTY

Professors: T. A. READ (Head of Department), R. W. BALLUFFI, P. A. BECK, R. W. BOHL, W. H. BRUCKNER, E. J. ECKEL, B. G. RICKETTS, W. D. ROSE, N. STREET, W. H. VOSKUIL, C. A. WERT, F. D. WRIGHT, R. G. WUERKER.

Associate Professors: G. R. Eadie, A. C. Forsyth, D. S. Lieberman, M. Metzger, R. M. Thomson, V. S. Tuman, E. K. Weise.
Assistant Professors: C. J. Altstetter, C. M. Wayman.

Mining Engineering

COURSES FOR GRADUATES

401. **Advanced Mineral Dressing and Coal Preparation.** Advanced theory and practice of mineral dressing and coal preparation processes. I or II; 1 unit. Wuerker.

402. **Mine Valuation, Taxation, and Mineral Economics.** A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. I or II; 1 unit. Wright.

403. **Advanced Mine Administration.** Current methods and systems of mine administration in use by major mining corporations. I or II; 1 unit. Eadie.

405. **Advanced Mine Ventilation.** Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. I; 1 unit. Eadie.

406. **Design of Underground Openings.** Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. II; 1 unit. Prerequisite: Mining Engineering 253. Wright.

497. **Special Problems.** Individual studies in areas of mining or petroleum engineering, not covered by regular course offerings, carried out under the supervision of a member of the staff. I, II; ½ to 2 units. Prerequisite: Consent of instructor. Staff.

499. **Thesis Research.** Individual research in some phase of the general field of mining or petroleum engineering and under the supervision of a member of the staff. I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **World Mineral Economics.** The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. II; ¾ to 1 unit. Voskuil.

304. **Mine Safety Engineering.** A detailed study of mine accident statistics, causes of accidents, accident prevention; consideration of insurance rates and cost of mine accidents; psychology of accident prevention; state and federal mining laws as related to safety. I; ¾ to 1 unit. Prerequisite: Consent of instructor. Eadie.

351. **Geophysical Prospecting.** Same as Geology 351. Principles of geophysics and their application to mining processes. I; ¾ to 1 unit. Prerequisite: Senior standing in engineering or geology, or consent of instructor. Wuerker.

354. **Mining Geology.** Same as Geology 354. Principles of ore deposition; relation of mineralogic and structural features to prospecting, exploration, development, and valuation of ore deposits. II; ¾ to 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Geology 101 or 150; Geology 130 or 131. Wright.

357. **Mine Plant Operation.** Haulage, hoisting, and pumping as related to transportation of men and materials. I; ¾ to 1 unit. Prerequisite: Electrical Engineering 230; Mechanical Engineering 201. Wuerker.

358. **Engineering Properties of Rocks.** Strength and elastic properties of rocks, their determination and utilization in comminution, roof control, and fracturing of wells; discussion of tests in free and confined state; sonic testing; applications to mineral engineering processes, such as drilling and blasting. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or consent of instructor. WUERKER.

365. **Phase Behavior of Hydrocarbons.** Introductory organic chemistry; phase behavior of gaseous and liquid hydrocarbon systems; elementary applications of reservoir fluid characteristics. I; ¾ to 1 unit. Prerequisite: Chemistry 245, 246, or consent of instructor. STREET.

371. **Petroleum Production Engineering.** Field development. Properties of petroleum, oil reservoirs, exploration and drilling methods, casing methods, and well logging. I; ½ to ¾ unit. Prerequisite: Consent of instructor.

372. **Petroleum Production Engineering.** Study of reservoir performance, principle of oil and gas recovery, storage and transportation, economics of oil field exploitation. II; ½ to ¾ unit. Prerequisite: Mining Engineering 371. ROSE.

373. **Advanced Reservoir Engineering.** Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. I; ¾ to 1 unit. Prerequisite: Mining Engineering 372 or consent of instructor; Mathematics 345. ROSE.

374. **Recovery of Petroleum.** An advanced treatment of the various methods of petroleum recovery from underground reservoirs, especially emphasizing secondary recovery methods. II; ¾ to 1 unit. Prerequisite: Mining Engineering 372 or consent of instructor. ROSE.

375. **Advanced Petroleum Engineering Laboratory.** Techniques of petroleum engineering research to evaluate the effectiveness of various methods for drilling and completing wells and for recovering petroleum from underground reservoirs. I, II; ¾ to 1 unit. Prerequisite: Mining Engineering 372, senior standing, or consent of instructor. STREET.

396. **Seminar.** Review of mining and petroleum literature; reports; technical writing. II; ¼ unit. STAFF.

Metallurgical Engineering

COURSES FOR GRADUATES

405. **Advanced Physics of Metals.** Introduction to quantum mechanics, theory and experiment, potential barrier problem, hydrogen atom, perturbation theories, application to the study of solids. I; 1 unit. Prerequisite: Mathematics 343 and 345; Physics 381 or 383; Metallurgical Engineering 318; or consent of instructor.

406. **Advanced Physics of Metals.** The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. II; 1 unit. Prerequisite: Physics 385 or consent of instructor.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. I; 1 unit. Prerequisite: Consent of instructor. BECK.

408. **Dislocations and Mechanical Properties of Metals.** General static and dynamic properties of single dislocations in crystals; dislocation interactions; properties of dislocation arrays; role of dislocations in metallurgical phe-

nomena with particular emphasis on mechanical properties. I; 1 unit. Offere in 1960-1961 and in alternate years. Prerequisite: Consent of instructor BALLUFFI.

409. **Crystal Physics.** The anisotropic properties of crystals treated by tensor an matrix methods with applications to paramagnetism, conduction and diffu sion, thermoelectricity, deformation, elasticity, and martensitic transforma tions. The effects of crystal symmetry and the properties of aggregates ar discussed. I; 1 unit. Prerequisite: Vector algebra, determinants, and thermo dynamics; consent of instructor. METZGER.

410. **Advanced X-ray Metallography.** X-ray diffraction as applied to the stud of metals and alloys; effects of cold work, annealing, substructures, preferre orientation and ordering, principles of electron and neutron diffraction. II 1 unit. Prerequisite: Chemistry 427 or consent of instructor. BECK.

420. **Metallurgical Thermodynamics.** Fundamental thermodynamic consideration and applications of thermodynamics to metallurgical problems; particula emphasis on heterogeneous equilibrium and thermodynamic properties o solutions; topics approached from the viewpoints of both macroscopic thermo dynamics and statistical mechanics. II; 1 unit. Prerequisite: Physics 360 o Chemistry 394 or consent of instructor. BALLUFFI.

421. **Kinetics of Phase Changes in Metals.** Characteristics of phase changes i solids; phenomenological analysis of nucleation and growth; the roles o diffusion, interfacial energy and strain energy; attempts at quantitativ treatment of crystallization, eutectoid decomposition, diffusionless phas changes, and precipitation. II; 1 unit. Prerequisite: Consent of instructor METZGER.

485. **Metallurgical Engineering Problems.** Individual study in areas of metallur gical engineering not covered by regular offerings, carried out under th supervision of a member of the staff. I, II; ½ to 2 units. STAFF.

493. **Seminar on Anelasticity.** Lectures and discussions of the nature of anelas ticity and its application to metallurgy. I, II; 0 to ¼ unit. Prerequisite Consent of instructor. WERT.

494. **Seminar on Phase Transformations in Metals.** Discussion of current researc in this field including presentation by graduate students of their own work I, II; 0 to ¼ unit. Prerequisite: Consent of instructor. LIEBERMAN, READ WAYMAN.

495. **Seminar on Diffusion and Imperfections.** Lectures and discussions on diffu sion and imperfections in crystalline solids. I, II; 0 to ¼ unit. Prerequisite Consent of instructor. BALLUFFI.

497. **Seminar on Recrystallization and Theory of Alloys.** Graduate students pre sent the results of their own research work and the results of recently pub lished research by other investigators principally in the fields of recovery subgrains, recrystallization, grain growth, textures, and alloys of the transi tion elements. I, II; 0 to ¼ unit. Prerequisite: Graduate standing in metal lurgical engineering. BECK.

498. **Colloquium in Physical Metallurgy.** Review of current metallurgical researc in other laboratories by visiting lecturers. Some of the research currentl done in the department is also reviewed. Required of all graduate student in metallurgical engineering. I, II; no credit.

499. **Thesis Research.** Individual research in specialized problems under the supervision of members of the staff. Results of research may be used fo graduate thesis. I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Metallurgy of Welding.** A survey is made of existing welding procedures and their metallurgical (ferrous and nonferrous) consequences with respect to the weld and base metal involved thermally in the welding operations. Heat flow in metals, arc behavior, slag behavior, and the physical metallurgy of heat-affected base metal are considered. Engineering phases of welding covered are economics of welding in relation to other methods of joining metals or producing engineering structures, thermal stresses, specification of materials for weld and base metal, and methods of production by means of welding and gas cutting. I or II; ¾ to 1 unit. Prerequisite: Metallurgical Engineering 208 and 210, or consent of instructor. Bruckner.

302. **Powder Metallurgy.** Production and testing of metal powders; fabrication and application of metal shapes produced from metal powders. II; ½ or ¾ unit. Prerequisite: Consent of instructor; registration in Metallurgical Engineering 304. Eckel.

304. **Powder Metallurgy Laboratory.** Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. II; ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302. Eckel.

311. **Advanced Phase Diagrams.** Interpretation of multicomponent phase diagrams. I; ½ unit. Prerequisite: Equivalent of the undergraduate courses required in metallurgical engineering. Eckel.

318. **Introduction to Metal Physics.** The free electron theory of metals, thermal and electrical conductivities, specific heat, thermo-electric effects, the Hall effect, motions of electrons in a periodic field, the band approximation, semiconductors and transistors, cohesion, ferro-magnetism, thermionic emission; the structure of alloy phases, diffusion in metals, order-disorder, phase precipitation by nucleation and growth. I; ¾ unit. Prerequisite: Chemistry 246, Metallurgical Engineering 209, or consent of instructor. Lieberman.

319. **Elements of the Theory of Alloys.** An introduction to the theory of alloys involving a thermodynamic and structural approach to the understanding of equilibrium diagrams. Topics covered include equilibrium, free energy of alloy phases, equilibrium diagrams, solid solutions, electron compounds, intermediate phases, order-disorder, etc. II; 1 unit. Prerequisite: Metallurgical Engineering 209, Metallurgical Engineering 318, and Chemistry 246. Wayman.

MUSIC

The School of Music offers the degrees of Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Degree of Master of Music. For the degree of Master of Music, the major field may be in musicology, music theory and composition, or applied music (organ, voice, piano, violin, viola, cello, solo wind instruments).

The admission requirement, in terms of grade-point average, is at least 3.5. In addition, an applicant for admission to graduate study in music is required (1) to have finished successfully a four-year undergraduate curriculum in music or music education, or its equivalent in hours and content, from an institution which holds membership in the Association of American Universities, or from a

liberal arts college recognized by the North Central Association or equivalent regional accrediting association, or from an independent conservatory or school of music whose four-year undergraduate curricula represent the equivalent in hours, content, and attainment of those offered at the University of Illinois; and (2) to pass a qualifying examination in the major field of concentration to be administered by the graduate committee of the School of Music. If the major is to be applied music or band and orchestra conducting, this examination is essentially one of performance on the major instrument and is given at specified times during the year. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of German or French is required. Each applicant must furnish the graduate committee of the School of Music a copy of his official undergraduate transcript. All prospective candidates for the Master of Music degree must take a placement examination in the history of music and the theory of music. These examinations determine the deficiencies, if any, which must be satisfied before the degree can be conferred. Courses considered as deficiencies do not carry graduate credit.

Degree of Doctor of Musical Arts. The degree of Doctor of Musical Arts is offered to candidates who are capable of demonstrating that kind of professional competence and artistic independence which results when technical skills and musical talent are supported by a thorough and comprehensive grasp of musical theory, of the history of the musical literature, of the evolution of styles and performance practices, and of the broad spiritual and aesthetic principles which underlie all artistic manifestations. The fields of specialization for the degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree programs comprise the following major areas: composition, choral music, piano, organ, violin, viola, cello, and voice.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to the program leading to the degree of Doctor of Musical Arts. The prerequisites for admission are as follows:

(1) The degree of Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent):

(a) Major in Composition: advanced composition, two units; theory, two units; Music 428, Problems and Methods, one unit; electives, three units;

(b) Major in Applied Music: applied music, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) Composition or performance honors awarded to the student on the basis of a program presented in connection with his work toward the master's degree.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) Superior work in Music 428 or its equivalent.

(5) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature, psychology, and philosophy. Students lacking an appropriate background in liberal arts and sciences when applying for admission to the program may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination. The graduate committee of the School of Music reserves the right to require a student to reinforce his preparation in areas which are relevant to his program of study by the successful completion of additional courses in the liberal arts and sciences.

(6) The successful completion of qualifying examinations administered by the graduate committee of the School of Music. These examinations in applied music, the history of music, and the theory of music must be taken within the first two or three weeks of the first semester or summer session in residence.

The examination in the history of music consists of: (a) two or three essay questions dealing with the various historical periods; and (b) unidentified pieces of music from various historical periods to be identified by means of style analysis.

The examination in the theory of music consists of: (a) ear recognition of progressively difficult intervals, harmonic dictation, and melodic dictation; (b) the writing of a fugue answer (usually tonal) to a given subject, and the writing of an invertible countersubject to the above; (c) harmonic analysis; (d) analysis of musical form.

If the candidate fails to pass the qualifying examinations, he must repeat all or parts of them in the same year of residence. Until the examinations have been passed, the student is considered to have a provisional status. All doctoral candidates must also take two verbal competence tests administered by the University Testing Bureau, 305 Administration Building (East).

After admission to the doctoral program the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, calendar, grades, and major and minor fields.

A minimum of sixteen units of graduate credit beyond the eight units required for the degree of Master of Music is necessary to earn the degree of Doctor of Musical Arts. In the fields of composition and applied music, three units are devoted to the completion of a special doctoral project: for the former, the writing of a representative original score on a large scale; for the latter, the study of a comprehensive repertory and the presentation of two full-length recital programs including solo and, where appropriate, chamber music works. Two units are devoted to the completion of an original thesis. In the field of choral music, one unit is devoted to a doctoral project involving the preparation and presentation of a choral program of approximately one hour in length selected from a comprehensive repertory. Four units are devoted to the completion of an original thesis.

In addition to the foregoing, the work includes the following required courses: composition or applied music, three units; Music 420, Seminar in Music Literature for Doctoral Candidates, two units. One unit of work must be taken in the field of education or music education unless the candidate has previously passed equivalent course work. At least two, but no more than four, units are devoted to an outside minor field. The outside minor field may be history, philosophy, psychology, related arts, English or other literature, sociology, acoustics, journalism, or education. Other minor fields may be accepted upon recommendation of the major adviser.

Of the six units of elective credit available within the total program, including the work toward the master's degree, at least three must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must complete the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College. For eligibility the student must (1) have completed a minimum of eight units of work beyond the master's degree including two units in composition, choral music, or applied music, two units in Music 420, Seminar in Music Literature, one unit in education or music education, and two units of the outside minor field; (2) have passed the required language examinations, of which one is in German and one in French, Italian, Spanish, or Russian as designated by the graduate committee, and also in one or more additional foreign languages where, in the opinion of the graduate committee, the knowledge of such language is necessary for proper research in

the student's field of concentration; and (3) have received the recommendation of his adviser.

The work to be covered in the final year of study (calculated on a full-time residence basis) normally is as follows: applied music, composition, or one area of the choral music program, one unit. In composition and applied music, doctoral project, three units; thesis, two units; electives, two units. In the field of choral music; doctoral project, one unit; thesis, four units; electives, two units.

After completion of the doctoral project, the thesis and the remaining course work, and upon recommendation of the graduate committee, the candidate is eligible for his final examination which must be held at least two weeks prior to the date when the degree is conferred. This examination is on the original score or, respectively, on the repertoire numbers, and on the thesis prepared by the candidate, but also covers broader aspects of the general field of music literature, history, and theory. It is conducted by a committee appointed by the Dean of the Graduate College.

Degree of Doctor of Philosophy in Musicology. The degree of Doctor of Philosophy in Musicology is offered in such fields of music as merit and demand research methods. It is intended for applicants whose interest lies in research in the history of music, theory of music, psychology of music, ethno-musicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College (see page 15), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to the program leading to the degree of Doctor of Philosophy. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the degree of Master of Music with a major in musicology or theory of music; (2) have acquired an adequate background of approximately thirty-two semester hours in the liberal arts and sciences, including general history, philosophy, psychology, and literature; (3) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music (see examination description under Doctor of Musical Arts).

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the minimum of sixteen units of doctoral credit necessary to earn the degree of Doctor of Philosophy must be in Music 499 and are devoted to the completion of an original doctoral thesis subsequent to the official admission of the student to candidacy. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or the equivalent, in courses including Music 320, 322, 414, 415, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in applied music. Credit for units not in music is granted toward the Doctor of Philosophy degree only where approved by the graduate committee as relevant to the student's field of specialization.

(2) A minimum of two units each in one or two of the following minor fields: history, philosophy, psychology, related arts, English or other literature, sociology, classics, anthropology, physics (acoustics), electrical engineering, journalism, or education. Other minor fields may be accepted upon recommendation of the major adviser.

(3) In addition to the general foreign language requirements of the Graduate College, an examination in one or more additional foreign languages when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(4) A preliminary examination administered by a committee appointed by the Dean of the Graduate College. This examination consists of a written examination on the history of music; a written examination in the area of the student's field of concentration, and an oral examination on the general field of musicology and on the content of the written examinations.

Degree of Master of Science in Music Education. Candidates for the degree of Master of Science in Music Education must earn four units in music, two units in education, and two units in electives. Requirements are four units of music; two courses from Education 301, 302, 303, 304, one unit; Education 311 and 312, one unit; and electives, two units. The electives must be selected with the approval of the adviser, and may be in music, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.5. All applicants for admission are required to satisfy placement examinations in music history, music theory, and performance in the principal applied music area.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the degree of Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music theory and applied music to determine the candidate's level of proficiency in those areas. A candidate whose level of proficiency is below that required by the University of Illinois for the Bachelor of Science degree in Music Education is required to take work in addition to the course work prescribed below under "Program."

Residence. The minimum residence requirement is one semester during which a minimum of three units is successfully completed, or two summer sessions during each of which a minimum of two units is successfully completed. All work for the certificate may be completed in summer sessions.

Program. A minimum of eight units of course work beyond the master's degree is required. All of the course work must be taken on the Urbana campus of the University. Music 440 and 441 and either Education 411 or 412 are required. The remainder of the program is based upon the student's needs and interests and upon the deficiencies revealed in placement tests. No more than one unit of applied music may be counted toward the certificate. With the prior approval of an adviser, courses in music which carry undergraduate numbers may be approved for credit. Such credit is computed at the rate of one-fourth unit for each semester hour of credit. No such credit can be counted toward the requirements of the degrees of Master of Science in Music Education and Doctor of Education with a major in music education.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Degree of Doctor of Education. The program leading to the degree of Doctor of Education with a major in music education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and

experience, and recommendation from persons who have known the candidate. Examinations administered by the School of Music include music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that necessary examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in music courses and six units of credit in education courses. No more than one unit of credit in applied music may be counted toward the degree. Students found deficient in applied music are expected to correct the deficiency in addition to the prescribed course work.

The following courses are required: Education 410, 415, Music 421, 440, and 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. Extramural course work may not be included as part of this sixteen-unit requirement. A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the degree of Doctor of Education with a music education major. A student may, with the approval of the advisers, plan a maximum of four units of work to be accomplished at other accredited institutions. No more than six units of credit earned at other universities may be included in the minimum sixteen-unit requirement.

A preliminary examination in music and education must be completed prior to the beginning of the dissertation. A student who has completed a minimum of eight units of course work subsequent to his admission may take the preliminary examination when it is recommended by his advisers. The preliminary examination is given by a committee composed of representatives from the School of Music and the College of Education appointed by the Dean of the Graduate College. The nature of the examination is determined by the committee. Part of the examination may be written. Part of it must be oral. Prior to admission to the preliminary examination the student is expected to demonstrate broad competence in professional education and in music and music education. Competence may be demonstrated by a grade of B or better in appropriate courses or by satisfactory completion of proficiency examinations.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

A final oral examination is held at least two weeks prior to the date the degree is conferred. The examination committee is appointed by the Dean of the Graduate College and should include representatives from both the School of Music and the College of Education. The final examination is primarily concerned with a report of the thesis study, but also extends over the whole field of the candidate's study.

Upon satisfactory completion of all degree requirements in both the School

of Music and the College of Education, the candidates are recommended for graduation by the School of Music.

GRADUATE TEACHING FACULTY

Professors: D. A. Branigan (Director of School of Music), B. Bergethon, Dorothy E. Bowen, H. A. Decker, S. Fletcher, B. R. Foote, J. C. Garvey, S. Goldthwaite, B. M. Goodman, M. H. Hindsley, H. Kessler, C. Leonhard, R. H. Miles, P. S. Pettinga, B. Phillips, D. Plamenac, P. Rolland, H. Schmitt, S. Schoonmaker, H. Sexton, S. Stravinsky, R. Swenson, G. R. Waller, Jane C. Watt, Velma Wilson, L. E. Zirner.

Associate Professors: J. Berger, G. W. Binkerd, A. M. Carter, L. Hamp, G. H. Hunter, K. Kellogg, J. R. Kelly, Colleen J. Kirk, E. D. Kisinger, A. J. McDowell, P. Painter, G. Reeves, Claire L. Richards, A. L. Ringer, Grace E. Wilson.

Assistant Professors: J. Allen, J. L. Bailey, Dorothy E. Clark, W. R. Coggins, C. DeLaney, P. Farrell, R. E. Gray, L. A. Hiller, T. L. Holden, B. Johnston, C. J. Kleinsteuber, E. J. Krolick, D. A. Ledet, W. H. Miller, Carolyn Powell, D. W. Sanders.

Visiting Lecturer: H. Johnson.

Instructors: E. S. Berry, J. H. McKenzie, M. Picker.

COURSES FOR GRADUATES

400. **Advanced Instrumentation: Chamber and Symphonic.** Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. I; ½ to 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. **Advanced Instrumentation: Band.** Arrange for the concert band, works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. II; ½ to 1 unit. Prerequisite: Undergraduate instrumentation. Hindsley.

402. **Analysis in Relation to Performance and Interpretation, I.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. I; 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. Leonhard.

403. **Analysis in Relation to Performance and Interpretation, II.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. II; 1 unit. Prerequisite: Music 402. Leonhard.

406. **Composition.** Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. I, II; ½ to 1½ units. Composition Faculty.

410. **History of Music Theory, I.** A study of selected theoretical treatises written before 1400. I; ½ to 1 unit.

411. **History of Music Theory, II.** A study of selected theoretical treatises written after 1400. II; ½ to 1 unit.

412. **History of Musical Aesthetics, I.** A survey of the principal philosophies of music, their historical backgrounds and their relation to musical styles. From

Pythagoreanism to the humanistic period. I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Graduate standing in music. RINGER.

413. **History of Musical Aesthetics, II.** A survey of the principal philosophies of music, their historical backgrounds and their relation to musical styles. From the seventeenth century to the present day. II; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Music 412. RINGER.

414. **Notation, I.** The history of notation from its beginning to 1400. I; ½ unit. Prerequisite: Consent of instructor. GOLDTHWAITE, PLAMENAC.

415. **Notation, II.** The history of notation from 1400 to 1600, including instrumental tablatures. II; ½ unit. Prerequisite: Music 414 or consent of instructor. GOLDTHWAITE, PLAMENAC.

416. **History of Instrumental Music to 1600.** A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. I; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Music 312 or consent of instructor. PLAMENAC.

417. **History of Instrumental Music from 1600 to 1750.** A study of instrumental music in the Baroque era. II; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Music 416 or consent of instructor. GOLDTHWAITE.

418. **The Origins and the History of Opera up to Gluck.** The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory and aesthetics of opera. The principal composers covered are Monteverdi, Cavalli, Cesti, Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. I; ½ unit. Prerequisite: Music 312 or consent of instructor. RINGER.

419. **Mozart.** A study of selected representative works from all fields and periods of Mozart's activity as a composer, with special emphasis on dramatic production. I; 1 unit. Prerequisite: Graduate standing in music or music education. PLAMENAC.

420. **Seminar in Music Literature.** Intensive study of outstanding works selected from all fields of music literature. Required of all students (except those in choral music) enrolled in the Doctor of Musical Arts program. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. GOLDTHWAITE.

421. **Seminar in Music Education.** An introduction to problems and methods of research in music education. Required of all candidates for the Doctor of Education degree in music education. I or II; 1 unit. Prerequisite: Graduate standing in music education or consent of instructor. BERGETHON.

422. **Seminar in Theory of Music.** Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. I, II; ½ or 1 unit. Prerequisite: Graduate standing in music theory or consent of instructor. KESSLER.

423. **Seminar in Musicology.** Problems in historical and systematic musicology. Discussions of special problems and reports on individual research. I, II; 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. PLAMENAC.

424. **Bach, I.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. I; ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music degree. MILES.

425. **Bach, II.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of

his creative activity. II; ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music degree. MILES.

426. **Beethoven, I.** I; ½ or 1 unit.

427. **Beethoven, II.** II; ½ or 1 unit.

428. **Problems and Methods.** An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports of bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. I; 1 unit. RINGER.

430. **Advanced Orchestra Conducting and Literature.** Intensive study of conducting techniques and problems related to standard orchestral literature. Includes a survey of materials for school and community orchestras. I or II; 1 unit. Prerequisite: Previous conducting experience. BERGETHON.

431. **Advanced Band Conducting and Literature.** I; 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Techniques.** An intensive laboratory approach to the development of advanced techniques necessary for working effectively with choral ensembles. I, II; 1 unit. Prerequisite: Graduate standing in music. KIRK.

433. **Advanced Choral Literature and Conducting.** An intensive survey of choral literature with laboratory organization for reading, conducting, and interpretation of choral music of all periods, styles, and voice arrangements. I or II; 1 unit. Prerequisite: Graduate standing in music; Music 432 or equivalent; consent of instructor. DECKER.

434. **Piano Literature.** I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. KESSLER.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. KELLOGG, REEVES.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. MILES.

437. **String Instrument Literature.** I, II; 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education degree; qualifying examination given by the graduate committee. FARRELL.

438. **Wind Instrument Literature.** An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance when possible, of the music itself, recordings, and collateral readings. I, II; 1 unit; maximum accumulated credit, 2 units. KISINGER, LEDET.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. I; ½ or 1 unit. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. II; ½ or 1 unit. LEONHARD.

442. **The General Music Program in Secondary Schools.** A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. I or II; ½ or 1 unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. **Administration and Supervision of Music Education.** Deals with the functions of supervisors and directors of music education in administering music programs in elementary and secondary schools. I or II; ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

444. **The General Music Program in Elementary Schools.** A detailed consideration of elementary general music, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. II; ½ unit. Prerequisite: Graduate standing in music education.

445. **Music in Higher Education.** An orientation to the organization, teaching, and administration of music in the college and university. I or II; ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

446. **Seminar and Laboratory in Musical Acoustics, I.** Special topics in acoustics including formant theory and communication theory. Application of electrical and electronic techniques to music reproduction and propagation; audio-visual aids. Individual projects for selected students. I; ½ or 1 unit. Prerequisite: Graduate standing in music or music education, or consent of instructor. HILLER.

447. **Seminar and Laboratory in Musical Acoustics, II.** Techniques of modern experimental electronic music; related music theory; computational music and related topics. Individual projects for selected students. II; ½ or 1 unit. Prerequisite: Music 446. HILLER.

450. **History of Vocal Ensemble and Choral Music, I.** A critical and analytic study of vocal and choral ensemble music from the Middle Ages to 1750. I; 1 unit. Prerequisite: Consent of instructor. BERGER.

451. **History of Vocal Ensemble and Choral Music, II.** A critical and analytic study of vocal and choral ensemble music from 1750 to the present. II; 1 unit. Prerequisite: Consent of instructor. BERGER.

480. **Graduate Applied Music (Piano).** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. GRADUATE FACULTY.

481. **Graduate Applied Music (Voice).** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. GRADUATE FACULTY.

482. **Graduate Applied Music (Organ).** Selected studies from the masterworks of organ literature. I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. GRADUATE FACULTY.

483. **Graduate Applied Music (String Instruments).** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. GRADUATE FACULTY.

484. **Graduate Applied Music (Wind Instruments).** I, II; ½ or 1 unit. Prerequisite: Bachelor of Music degree; qualifying examination given by the graduate committee. GRADUATE FACULTY.

489. **Doctoral Projects.** Special projects for candidates for the degree of Doctor of Musical Arts. Open only to students in the Doctor of Musical Arts program. I, II; 1 to 3 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

499. **Thesis Research.** Research in special projects. I, II; 0 to 4 units. Prerequisite: Consent of adviser. GRADUATE FACULTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Counterpoint, I.** Creative writing in linear counterpoint of the following: rounds, instrumental and vocal; canons; inventions; and fugues. Analysis of Bach *Inventions* and the *Well-Tempered Clavier.* I; ½ unit. Prerequisite: Music 104. JOHNSON, JOHNSTON.

301. **Advanced Counterpoint, II.** Creative writing in linear counterpoint of the following: rounds, instrumental and vocal; canons; inventions; and fugues. Analysis of Bach *Inventions* and the *Well-Tempered Clavier.* II; ½ unit. Prerequisite: Music 300. JOHNSON, JOHNSTON.

302. **Fugue, I.** Systematic practice in writing the various parts of the fugue, together with analysis of fugues by Bach and Handel. I; ½ unit. Prerequisite: Music 104 and/or consent of instructor. JOHNSTON.

303. **Fugue, II.** Continuation of Music 302, including the writing of complete fugues and analysis of fugal composition of the nineteenth and twentieth centuries. II; ½ unit. Prerequisite: Music 302 and/or consent of instructor. JOHNSTON.

304. **Analytical Techniques, I.** Examination of music from plain song and the earliest polyphony to the close of the sixteenth century. Emphasis is placed upon penetration of the compositional techniques used and includes the study of form and harmony as these bear on the problems. I; ½ unit. Prerequisite: Music 104 or consent of instructor. PHILLIPS.

305. **Analytical Techniques, II.** Continuation of Music 304, beginning with the early seventeenth century and coming down to the present day. II; ½ unit. Prerequisite: Music 304 or consent of instructor. PHILLIPS.

306. **Composition.** Work in original composition including the small and large homophonic forms. I, II; ½ or 1 unit. Prerequisite: Music 104 or 106 or consent of instructor. COMPOSITION FACULTY.

307. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. I; ½ unit. Prerequisite: Consent of instructor. BINKERD, JOHNSON.

308. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Continuation of Music 307. II; ½ unit. Prerequisite: Music 307. BINKERD, JOHNSON.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. I; ½ unit. Prerequisite: Music 112. PICKER.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. II; ½ unit. Prerequisite: Music 310. PICKER.

312. **Music of the Baroque and Classical Periods.** A history of music from about 1600 to 1800. I; ½ unit. Prerequisite: Music 311. BERGER.

313. **Music of the Nineteenth and Twentieth Centuries.** A history of music from about 1800 to the present. II; ½ unit. Prerequisite: Music 312. RINGER.

315. **Contemporary Music.** A survey of all important trends, forms, and styles of modern music from 1875 to the present. I, II; ½ unit. Prerequisite: Consent of instructor. BERGER.

318. **History of Performance Practices, I.** The study of musical performance

from about 900 to 1600 A.D. Discussion of musical instruments, make-up of instrumental and vocal ensembles, etc., are supplemented by demonstration performances of selected works using the University's collection of instruments. I or II; ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

319. **History of Performance Practices, II.** The study of musical performance from 1600 to 1750 A.D. Discussion of musical instruments, ornamentation, basso continuo, etc., are supplemented by demonstration performances using the University's collection of instruments. I or II; ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

320. **Proseminar.** Provides special preparation in specialized fields of musicology, music education, theory, and composition. I, II; ½ or 1 unit; maximum credit, 2 units. Prerequisite: Senior or graduate standing in music or music education and consent of instructor. STAFF.

322. **Introduction to Musicology.** A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. I, II; ½ unit; maximum accumulated credit, 1 unit. GOLDTHWAITE, PLAMENAC.

323. **Opera Production, I.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. I; ½ unit. Prerequisite: Music 265 and 381; consent of instructor. ZIRNER.

324. **Opera Production, II.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are to be investigated and practiced. II; ½ unit. Prerequisite: Music 323. ZIRNER.

330. **Applied Music Pedagogy.** Survey of techniques, practices, and materials. Presentation of group and individual instruction. An approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. I, II; ½ unit; maximum accumulated credit, 1 unit. Prerequisite: Junior standing or consent of instructor. FLETCHER, POWELL, ROLLAND.

332. **Church Music Literature.** Survey of the development of church music with emphasis on the period since 1500. I; ½ unit. Prerequisite: Music 214 or 311, or consent of instructor. PETTINGA.

333. **Church Music Techniques.** The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. II; ½ unit. Prerequisite: Music 332 or consent of instructor. PETTINGA.

340. **Instrumental Clinic and Band Pageantry.** A study of the peculiarities of the individual instruments, criteria for selection, and accepted teaching methods and procedures for each instrument. Band pageantry deals with formation designing, charting and show continuity, marching fundamentals, and special problems. I; ½ unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

341. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. II; 1 unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

342. **Percussion Methods.** Designed primarily for teachers of school music who

may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. I or II; ½ unit. Prerequisite: Senior or graduate standing in music education. McKenzie.

344. **Methods of String Class Teaching.** Designed primarily for teachers of school music who are not performers on a string instrument yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Senior or graduate standing in music education or consent of instructor. Waller.

345. **Teaching Techniques of Music Theory.** Techniques and materials used in the teaching of theory of music in senior high school and junior college. I or II; ½ unit. Prerequisite: Music 300 or consent of instructor. Carter.

346. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools. S; ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: One year of teaching experience or consent of instructor. Bergethon, Leonhard.

347. **Teaching of Woodwind Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1960 and in alternate years. Prerequisite: Senior or graduate standing in music education, or consent of instructor. McDowell.

348. **Teaching of Brass Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1961 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. Sexton.

349. **Music in Early Childhood.** A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. I, II; ½ unit. Prerequisite: Senior or graduate standing in music education or child development.

350. **Advanced Ensemble Music.** Selected projects in the study and performance of ensemble literature including the areas of operatic, instrumental, and vocal-choral literature and accompanying. I, II; ½ unit. Prerequisite: Registration in applied music at the 300 level; consent of instructor. Garvey, Hunter, Reeves, Zirner.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

380. Piano. I, II; ½ or 1 unit. S; ¼ or ½ unit. Fletcher, Richards, Sanders, Schoonmaker, Stravinsky, Watt, Zirner.

381. Voice. I, II; ½ or 1 unit. S; ¼ or ½ unit. Bailey, Bowen, Clark, Foote, Hamp, Kellogg, Miller, Wilson.

382. Organ. I, II; ½ or 1 unit. S; ¼ or ½ unit. Miles, Pettinga.

383. Violin. I, II; ½ or 1 unit. S; ¼ or ½ unit. Rolland, Schmitt, Totenberg.

384. Viola. I, II; ½ or 1 unit. S; ¼ or ½ unit. Garvey.

385. **Cello.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Farrell, Swenson.
386. **String Bass.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Krolick.
387. **Flute.** I, II; ½ or 1 unit. S; ¼ or ½ unit. DeLaney.
388. **Clarinet.** I, II; ½ or 1 unit. S; ¼ or ½ unit. McDowell.
389. **Oboe.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Ledet.
390. **Bassoon.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Berry.
391. **Cornet and Trumpet.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Sexton.
392. **French Horn.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Holden.
393. **Trombone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Gray.
394. **Baritone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Gray.
395. **Tuba.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Gray.
396. **Percussion.** I, II; ½ or 1 unit. S; ¼ or ½ unit. McKenzie.
397. **Harp.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Kleinsteuber.
398. **Saxophone.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Coggins.
399. **Harpsichord.** I, II; ½ or 1 unit. S; ¼ or ½ unit. Hunter.

NUCLEAR ENGINEERING

The interdepartmental committee on nuclear engineering offers graduate work leading to the degree of Master of Science in Nuclear Engineering and provides courses and research facilities for doctoral candidates in related fields.

The curriculum leading to the master's degree in nuclear engineering is open to all graduates in engineering and the physical sciences with a grade-point average of at least 3.75.

Undergraduate courses in differential equations, advanced calculus, atomic physics, and nuclear physics are required as background for the nuclear engineering program. A student will be admitted to the program before he has completed these four required prerequisites, but he must then allow for an additional semester or summer of work for the completion of the master's program. Other undergraduate courses of particular value to the future nuclear engineer include thermodynamics, fluid mechanics and heat transfer, stress analysis, physical metallurgy, solid state physics, electronics, and circuit analysis.

The master's degree requires eight units including a thesis or nine units without a thesis. At least four of these units must be in nuclear engineering courses. The remaining courses are electives which have been approved by the candidate's adviser.

A 100-kilowatt TRIGA Mark II reactor is located on campus for teaching and research in nuclear engineering. Other experimental facilities include a nuclear metallurgy laboratory, a radiochemistry and nuclear instrumentation laboratory, a boiling water heat transfer loop, and several subcritical natural uranium assemblies.

Attention is called to the four units of electives in the master's program. These units may be used in fulfilling course requirements for a doctoral program in other related departments.

For further information on joint programs, see the booklet, "Nuclear Engineering at the University of Illinois," available from the College of Engineering, 106 Civil Engineering Hall, or correspond with the chairman of the Committee on Nuclear Engineering, College of Engineering.

GRADUATE TEACHING FACULTY

Professors: R. J. Martin (Chairman of Nuclear Engineering Committee), F. T. Adler, R. W. Bohl, A. P. Boresi, B. T. Chao, A. O. Hanson, R. F. Larson, J. W. Westwater, M. E. Wyman.
Associate Professors: B. B. Ewing, D. F. Hang, M. S. McVay.
Assistant Professor: J. P. Hummel.

COURSES FOR GRADUATES

401. **Fundamentals of Nuclear Engineering.** A lecture and problem course to provide background for further work in nuclear engineering. Problems in materials, heat transfer, and fluid flow and elementary reactor physics. Special emphasis is placed on basic ideas and the mathematical similarity of problems in heat transfer, fluid flow, and neutron diffusion. I; 1 unit. Prerequisite: Physics 282 or 382 and Mathematics 345, or equivalent, or consent of instructor.

431. **Nuclear Metallurgy.** Metallurgical principles applied to materials, problems in nuclear engineering, including topics in production of uranium, in corrosion, radiation damage, fuel element fabrication, and fuel reprocessing. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering or consent of instructor.

451. **Reactor Laboratory.** Reactor operation: start-up, changes in power level, and shut down. Reactor instrumentation. Subcritical assemblies. Flux measurements in core and thermal column; control rod worth measurements; effects of changes in fuel configurations; neutron beam and activation experiments. I, II; ½ to 1 unit. Prerequisite: Consent of instructor.

454. **Nuclear Engineering Laboratory Investigations.** Special investigations in nuclear engineering, including aspects of metallurgy, heat transfer, instrumentation, measurement, and control. I, II; ½ to 1½ units. Prerequisite: Physics 282 or 382, or consent of instructor.

455. **Reactor Physics.** An introduction to the physical concepts of reactor analysis. Nuclear cross sections. Diffusion, slowing down, and thermalization of neutrons. Reactor kinetics. Use of analog and digital computers in solving problems of neutron transport and reactor kinetics. II; 1 unit. Prerequisite: Physics 282 and 383 or equivalent, plus Mathematics 343 and 345, or consent of instructor.

458. **Nuclear Reactor Engineering.** Development of engineering design phases of the fission chain reactor; reactor materials and radiations, thermal aspects, heat removal, radiation hazards, shielding, reactor performance, controls and instrumentation, types and applications, fuel conversion, reactor power economics. II; 1 unit. Prerequisite: Consent of instructor.

490. **Special Topics in Nuclear Science and Engineering.** Discussion of special topics such as reactor materials and fuels, control and instrumentation of nuclear reactors, radioactive waste disposal, reactor heat transfer, radiation damage, shielding, thermonuclear problems and devices. I, II; ½ to 1 unit. Prerequisite: Consent of instructor.

495. **Nuclear Engineering Problems.** Individual study in areas of nuclear engineering and closely related fields not covered by regular course offerings. The work is carried out under the supervision of a member of the staff. I, II; ½ to 2 units. Prerequisite: Three units of graduate work; consent of instructor.

497. **Seminar in Nuclear Science and Engineering.** Lectures and discussions on

research and development in nuclear engineering and related fields by staff, advanced students, and visiting lecturers. I, II; 0 to ¼ unit.

499. **Thesis Research.** I, II; 0 to 1 unit.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

347. **Introduction to Nuclear Engineering.** Nuclear particles and nuclear chain reactions, energy release from fission; classification of nuclear reactors; fast and thermal reactors; reactor theory; slowing down and diffusion of neutrons; radiation shielding; materials of construction, radiation damage; reactor instrumentation, safety, and control; chemical processing of nuclear materials. I, II; ¾ to 1 unit. Prerequisite: Physics 282 and senior standing in engineering, or consent of instructor.

397. **Radiochemistry.** Same as Chemistry 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, and interactions of radiations with matter. I, II; ½ unit. Prerequisite: One semester of physical chemistry or consent of instructor.

398. **Radiochemistry Laboratory.** Same as Chemistry 398. Laboratory to accompany Nuclear Engineering 397. I, II; ½ unit. Prerequisite: Credit or registration in Nuclear Engineering 397, or consent of instructor.

PHILOSOPHY

The Department of Philosophy offers graduate work leading to the Master of Arts and Doctor of Philosophy degrees.

Students undertaking graduate work with philosophy as their major subject must have had a grade-point average of at least 3.75. In addition, students majoring in philosophy should have had a course in logic, a course in ethics, and a general course in the history of philosophy. Students with deficiencies are required to fill them by taking Philosophy 102 (or 333), 321, or 303-306, respectively, in addition to the minimum requirement of eight units for the master's degree.

Degree of Master of Arts. A candidate for this degree must choose at least one course in each of the following three fields: history of philosophy; theory of knowledge, including logic and philosophy of science; and theory of value, including ethics and aesthetics. In addition to completing eight units of graduate work, the candidate must take an oral examination on the work represented by these units. His adviser arranges and presides at this examination. Applications to have the thesis requirement waived are not approved except on recommendation of the adviser and vote of the department.

Degree of Doctor of Philosophy. A candidate for this degree carries on (1) major studies in one of the three fields within the department; (2) minor studies amounting to at least two units in each of the two remaining fields; and (3) minor studies amounting to at least two units in a department other than philosophy. The three fields within the Department of Philosophy are history of philosophy; theory of knowledge, including logic and philosophy of science; and theory of value, including ethics, social philosophy, and aesthetics. The candidate's choice of major and minors must be approved by the department.

The preliminary examination for the doctor's degree, in addition to the major and minor subjects, presupposes first-hand acquaintance with at least one major work of Plato, Aristotle, Augustine or Aquinas, Descartes, Spinoza, Leibniz, Locke, Berkeley, Hume, Kant, and Hegel.

The details of the special departmental requirements for graduate degrees can

be obtained in mimeographed form by addressing a request to the Department of Philosophy, 119 Lincoln Hall.

GRADUATE TEACHING FACULTY

Professors: D. W. Gotshalk (Chairman of Department), M. H. Fisch, A. R. Turquette, F. L. Will.
Associate Professors: B. J. Diggs, O. A. Kubitz, L. Linsky, H. M. Tiebout.
Assistant Professors: P. Diesing, H. S. Harris.
Instructors: C. E. Caton, R. Grossman.

COURSES FOR GRADUATES

401. **Seminar in Ancient Philosophy.** I; 1 unit.
402. **Seminar in Ancient Philosophy.** II; 1 unit. Fisch.
403. **Seminar in Medieval Philosophy.** I and/or II; 1 unit. Diggs.
405. **Seventeenth-Century Continental Thought (Descartes, Spinoza, Leibniz).** A study of the basic philosophical works of the three leading continental thinkers of the century. I and/or II; 1 unit.
407. **British Empiricism.** I and/or II; 1 unit. Turquette.
408. **German Idealism (Kant).** I and/or II; 1 unit. Gotshalk.
409. **Recent American Philosophy.** Major American philosophers and movements since about 1900. Reports and discussions. I and/or II; 1 unit. Fisch.
411. **Seminar in Recent Ethical Theory.** I and/or II; 1 unit. Diggs, Fisch.
412. **Seminar in Social Philosophy.** A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. Students may receive credit more than once. I and/or II; 1 unit. Diggs.
413. **Logical Theory.** I and/or II; 1 unit. Prerequisite: A course in logic or consent of instructor. Turquette.
420. **Seminar in Semantics.** Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. I and/or II; 1 unit. Linsky.
421. **Seminar in Contemporary Problems.** Intensive study of selected problems on topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. I and/or II; 1 unit. Will.
422. **Seminar in Contemporary Problems.** Intensive study of selected problems on topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. I and/or II; 1 unit. Fisch, Will.
423. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. I; 1 unit. Will.
424. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. II; 1 unit. Will.
430. **Seminar in Modern Aesthetics.** I and/or II; 1 unit. Gotshalk.
483. **Individual Topics.** I, II; ½ to 2 units. Staff.
499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **History of Greek and Roman Philosophy.** I; 1 unit. Fisch.
304. **History of Medieval Philosophy.** Lectures and readings in the history of philosophy from St. Augustine to William of Ockham. II; ¾ to 1 unit. Prerequisite: Philosophy 101 or 303, or consent of instructor. Diggs.

306. **History of Modern Philosophy.** II; 1 unit. GOTSHALK.

309. **The Philosophy of Plato.** I, II; ¾ to 1 unit. Prerequisite: Philosophy 101 or 303. HARRIS.

311. **Philosophic Ideas of the Nineteenth and Twentieth Centuries.** I, II; ¾ to 1 unit. HARRIS, TIEBOUT.

313. **American Philosophy.** The history of philosophy in America from colonial times to the present. II; ¾ to 1 unit. Prerequisite: One course in philosophy. FISCH.

317. **Great Books in Modern Thought.** Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. I; ¾ to 1 unit. Prerequisite: One course in philosophy. WILL.

319. **Philosophical Ideas in Latin America.** A survey of the main philosophical currents and thinkers of Latin America. I; ½ to 1 unit. Prerequisite: One course in philosophy or consent of instructor. KUBITZ.

321. **Ethics and Value Theory.** I; ¾ to 1 unit. Prerequisite: One course in philosophy. DIGGS, FISCH.

323. **Philosophy of Art.** A discussion of the main philosophical principles of art and of outstanding contemporary philosophies of art. I; ¾ to 1 unit. GOTSHALK.

324. **Philosophy of Religion.** II; ¾ to 1 unit. Prerequisite: One course in philosophy.

326. **Metaphysics.** II; ¾ to 1 unit. Prerequisite: One course in philosophy. LINSKY.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. I; ¾ to 1 unit. Prerequisite: One course in philosophy. TURQUETTE.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. II; ¾ to 1 unit. Prerequisite: One course in philosophy. WILL.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method, and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. I, II; ¾ to 1 unit. Prerequisite: One course in philosophy. LINSKY, WILL.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. I; ¾ to 1 unit. TURQUETTE.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. II; ¾ to 1 unit. Prerequisite: Philosophy 333 or consent of instructor. TURQUETTE.

335. **Social Philosophy.** The nature of social organization as seen from economic, moral, and political standpoints; various senses of freedom; relations between organization and freedom; the free society. I; ¾ to 1 unit. Prerequisite: One course in philosophy. DIESING.

336. **Philosophy of Law and of the State.** II; ¾ to 1 unit. Prerequisite: One course in philosophy. DIESING.

337. **Semantics.** An investigation of semantical concepts such as denoting and truth. A study of the functions of language, definition, meaning and veri-

fication, semantical paradoxes. I; ¾ to 1 unit. Prerequisite: One course in philosophy. LINSKY.

340. **The Philosophy of Alfred North Whitehead.** An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas,* taking into account both the cosmological scheme and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. II; ¾ to 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

341. **Existentialism.** An introduction to contemporary philosophical existentialism. I; ¾ to 1 unit. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

350. **Philosophy and Modern Life.** A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. I or II; ¾ to 1 unit. Prerequisite: One course in philosophy. GOTSHALK.

361. **Comparative Religions: The Religions of the East.** A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. I; ¾ to 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

362. **Comparative Religions: The Religions of the West.** A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity, and Islam. II; ¾ to 1 unit. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

363. **Contemporary Religious Thought.** An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. II; ¾ to 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: One course in philosophy or consent of instructor. TIEBOUT.

PHYSICAL EDUCATION

The department offers programs of graduate study leading to the degrees of Master of Science and Doctor of Philosophy in Physical Education. Both programs are centered in training teachers, administrators, and research workers in the general field of physical education, including sport, dance, and exercise. The Ph.D. program also permits candidates to specialize in the areas of health education, safety education, and recreation. (See Health and Safety Education, page 171, and Recreation, page 271.)

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for the last two years of undergraduate study; (2) thirty hours of approved undergraduate credit in physical education or related fields; (3) eighteen hours of approved undergraduate credit in science; (4) sixteen hours of undergraduate credit in education; and (5) a course in statistics or measurement.

Degree of Master of Science. Graduation requirements for this degree are eight units to include (1) four units of credit in physical education or related courses (health education or recreation); (2) two units of credit in education including two of the following: Education 301, 302, 303, 304; and Education 311 and 312; (3) registration in and satisfactory completion of Physical Education 490 for one semester, no credit; (4) presentation of an acceptable thesis, two units.

Candidates may petition to waive the thesis and seminar requirements. Those who are excused are required to secure two units' credit in lieu of thesis credit (item 4) and in addition are required to take and pass a final comprehensive written examination in physical education and related fields.

Degree of Doctor of Philosophy. Graduation requirements for this degree are twenty-four units of graduate credit (equivalent of ninety-six hours of credit) including (1) a minimum of eight units of credit in physical education courses or related courses in health education, safety education, or recreation, (2) one minor for a minimum of four units, or two minors for a minimum of two units each, (3) registration in and satisfactory completion of Physical Education 490, and (4) presentation of an acceptable thesis for approximately eight units.

Each candidate must pass a reading examination in French and German. No student is considered as beginning his second year of graduate work until he has passed one of these examinations. Both examinations must be passed before taking the preliminary examination.

Each candidate must pass a written examination covering his major field of study and an oral examination covering his major and minor fields of study. This preliminary examination is given toward the end of the second year of study or, by special permission, at the beginning of the third year.

Each candidate must pass a final examination, principally on his thesis. This examination must be taken at least two weeks before the degree is to be conferred.

GRADUATE TEACHING FACULTY

Professors: S. C. Staley (Dean of College of Physical Education), T. K. Cureton, Jr., Laura J. Huelster, C. O. Jackson, H. E. Kenney, C. G. Knapp.

Associate Professors: A. W. Hubbard, Ann E. Jewett, R. E. Shelton.

Assistant Professors: A. J. Barry, Olive G. Young.

COURSES FOR GRADUATES

401. **Problems in Physical Education.** Biological, physiological, social, psychological, and other purposes and outcomes; selection and distribution of activities; teaching methods; facilities; teacher preparation; literature; research problems. I or II; 1 unit. Huelster, Jackson, Kenney.

406. **Philosophy of Sport.** History of sport; cultural, educational, economic, health character, personality, military, therapeutic, and other implications; types and extent of participation; organization; literature; research programs. I or II; 1 unit. Jackson, Kenney.

407. **Sport Psychology.** Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, perception and emotion in sport situations; review of literature; independent projects. I or II; 1 unit. Prerequisite: Psychology 100; Education 211; consent of instructor. Hubbard.

408. **Principles of Kinesiotherapy.** Analysis of medically approved techniques employed in the treatment of disease and injury by exercise and movement; kinesiological evaluation of principles involved; therapy preparation in teaching techniques; medically prescribed clinical training; literature; research. I, II; 1 unit. Prerequisite: Anatomy, physiology, kinesiology, and physiology of exercise, or consent of instructor. Shelton.

450. **Trends and Techniques in Rehabilitation.** Philosophy of rehabilitation; education of the handicapped (blind and partially sighted, deaf and hard of hearing, mentally handicapped, socially maladjusted, crippled, cardiac, epi-

leptic, speech deviate, etc.); state, federal, and community education and vocational training programs; literature; research. I or II; 1 unit. STAFFORD.

451. **Scientific Foundations of Physical Fitness.** Scientific basis for physical fitness; analysis of fitness programs; analysis of fitness tests; techniques in remedial clinics; literature; research. Includes laboratory session. I or II; 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. BARRY, CURETON.

452. **Scientific Analysis of Physical Education Activities.** Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. I or II; 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. BARRY, CURETON.

453. **Anthropometrical and Body Mechanics Research Techniques.** Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. I; 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. CURETON.

490. **Seminar.** Presentation and criticism of student theses; lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders. I, II; no credit. STAFF.

493. **Special Projects.** Independent research on special projects. Open only to students working toward the doctor's degree. I, II; ½ to 2 units. STAFF.

495. **Techniques of Research in Health, Physical Education, and Recreation.** Review and appraisal of common research procedures; application of statistical procedures, library methods, evaluation procedures, and experimental methods. I or II; 1 unit. CURETON, HUBBARD.

499. **Thesis Research.** Preparation of theses in physical education. I, II; 0 to 4 units. STAFF.

PHYSICAL SCIENCES

A special program leading to the degree of Master of Science in the Physical Sciences is available to meet the needs of students who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit carry credit toward the degree. To qualify for the degree, a student must have had, or must include in his program, at least one course in mathematics beyond calculus, and for which calculus is prerequisite.

Candidates for the degree of Master of Science in the Teaching of the Physical Sciences must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: Education 301, 302, 303, 304, one unit; and Education 311 and 312, one unit. The courses in the physical sciences and the electives must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or in exceptional cases, in other fields. Students

applying for admission must have a grade-point average of at least 3.5. Th adviser for candidates for this degree is Professor T. L. Brown, 456 Noye Laboratory.

PHYSICS

The Department of Physics offers graduate work leading to the Master o Science and Doctor of Philosophy degrees.

There is opportunity for specialization in atomic and nuclear physics, includ ing research with the betatrons, the cyclotron, and with radioactive sources; ir nuclear magnetic resonance; in theoretical physics; in the physics of solids including research on ionic crystals, metals, semi-conductors, cryogenics, anc surface physics.

The requirements for admission to the Graduate College with a major ir physics are twenty semester hours in physics, including Physics 321, 341, and 342 or the equivalent, and excluding courses in general physics, and a grade-point average of at least 3.75. Students who lack some of the prerequisite courses may be admitted but are required to take the prerequisite courses without graduate credit.

The requirements for the Master of Science degree in physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the degree of Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department.

Candidates for the degree of Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Education 311, 312, and one additional unit in education selected from Education 301, 302, 303, and 304. Students applying for admission must have a grade-point average of 3.5. The adviser for candidates for this degree is Professor G. M. Almy, 211 Physics Building.

For information concerning applied mathematics, see page 212; for information about biophysics see page 253. A new Ph.D. program in chemical physics is described on page 81.

GRADUATE TEACHING FACULTY

Professors: F. Seitz (Head of Department), F. T. Adler, J. S. Allen, G. M. Almy, D. Alpert, P. Axel, J. Bardeen, J. Bartlett, Jr., R. A. Becker, R. M. Brown, H. Frauenfelder, E. Goldwasser, A. O. Hanson, R. D. Hill, R. I. Hulsizer, Jr., J. D. Jackson, J. Koehler, P. G. Kruger, L. S. Lavatelli, D. Lazarus, E. M. Lyman, D. E. Mapother, R. J. Maurer, K. Nishijima, A. T. Nordsieck, D. Pines, C. S. Robinson, C. W. Sherwin, C. P. Slichter, J. N. Snyder, A. Wattenberg, M. E. Wyman.

Associate Professors: G. Ascoli, F. C. Brown, L. J. Koester, Jr., R. Novick, D. G. Ravenhall, R. D. Rawcliffe, J. H. Smith, J. C. Wheatley, H. W. Wyld.

Assistant Professors: L. D. Fosdick, P. Handler, U. E. Kruse, J. R. Schrieffer.

COURSES FOR GRADUATES

400. **Problems and Methods of Mathematical Physics.** Matrices and tensors; analytic functions of a complex variable; conformal mapping; contour inte-

gration; ordinary differential equations: solutions at singular points, contour integral solutions, asymptotic expansions; eigenfunctions and eigenvalues; partial differential equations: Laplace's equation, wave equation, diffusion equation, Green's functions; Legendre, Bessel, confluent hypergeometric, Mathieu, and elliptic functions; elementary difference equations. I; 1 unit. Prerequisite: Mathematics 342, 345, 347, or 387; Physics 322 and 342; or consent of instructor.

422. **Dynamics and Non-Linear Mechanics.** Hamiltonian mechanics: Lagrange equations, Hamilton's canonical equations, contact transformations, Lagrange and Poincare invariants, Hamilton-Jacobi equation and Huygens' principle; perturbation theory, relaxation oscillations and stability of periodic motion, theory of cosmotron orbits, three-body problem. II; 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. **Relativity and Cosmology.** Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. I; 1 unit. Prerequisite: Consent of instructor.

435. **Conduction of Electricity in Solids.** Same as Electrical Engineering 435. Application of quantum principles to conduction of electricity in solids, impurity and intrinsic semiconductors, Hall and thermoelectric effects, photoconductivity, p-n junctions and rectifying contacts, theory and characteristics of transistors. II; 1 unit. Prerequisite: Physics 381 or 383, or Electrical Engineering 425 or consent of instructor.

436. **Selected Topics in Physics of Solids.** The following topics are offered in rotation, one or two each semester:

(a) **Imperfections in Metals.** Influence of point imperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, physical properties on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) **Imperfections in Ionic Crystals.** Theory of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the electronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.

(c) **Advanced Quantum Theory of Solids.** Theory of electrons in crystals on basis of Bloch theory and Brillouin zone structure with applications to various problems such as cohesive energy of metals, magnetic properties and the de Haas-van Alphen effect, optical properties, spin orbit interactions, excitons and energy transfer. 1 unit. Prerequisite: Physics 486 and 490.

(d) **Conduction in Metals and Semiconductors.** Electrical and thermal conduction, transverse effects, magneto-resistance, vibrational motion and electron-lattice interactions, semiconductors, superconductivity. 1 unit. Prerequisite: Physics 485 and 490.

(e) **Magnetic Properties of Solids.** Quantum theory of diamagnetism, paramagnetism, ferromagnetism; elements of magnetic resonance and relaxation. 1 unit. Prerequisite: Physics 480, 481, and 482; Physics 489 and 490; or consent of instructor.

441. **Electrodynamics.** Electrostatics; Laplace's and Poisson's equations; boundary value problems; spherical harmonics; multipole potentials; dielectrics; microscopic and macroscopic fields; electric susceptibility; magnetostatics; magnetic

multipoles; magnetic media; conducting media; Maxwell's equations; field energy and momentum; electromagnetic waves; reflection and refraction dispersion; wave packets; causality; diffraction; wave guides and cavity resonators; simple aspects of magnetohydrodynamics and plasmas. I; 1 unit Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor.

442. **Electrodynamics.** Special theory of relativity; covariant formulation of electrodynamics; charged particle dynamics; high energy particle accelerators; energy loss by charged particles traversing matter; multiple scattering Lienard-Wiechert potentials; radiation by charged particles; radiation loss in particle accelerators; Thomson scattering; bremsstrahlung; Weiszacker-Williams method; inner bremsstrahlung; Cerenkov radiation; radiative reaction; natural line breadth; multipole expansion of radiation field Lagrangian and Hamiltonian formulation of electrodynamics. II; 1 unit Prerequisite: Physics 441.

463. **Statistical Mechanics.** Statistical ensembles; the Maxwell-Boltzmann law approach to equilibrium; quantum statistical mechanics; application of statistical mechanics to thermodynamic processes. I; 1 unit. Prerequisite: Physics 422; Physics 360 or 362.

464. **Dynamics of the Earth's Atmosphere.** Same as Astronomy 464 and Mathematics 464. Introduction to the hydrodynamics and thermodynamics of a gas in motion. Application to meteorology: types of winds, air masses, meteorological fronts, effects of friction, energy balance of atmosphere, perturbations. I or II; 1 unit. Prerequisite: Consent of instructor.

480. **Quantum Mechanics, I.** This course and Physics 481 should be taken as early as feasible by all graduate students in physics. Introduction to concepts of quantum theory, with applications. Review of classical Lagrangian mechanics; historical review of quantum phenomena, Bohr theory, and the wave nature of matter; Schrödinger wave equation; one-dimensional potential well and barrier penetration problems; three-dimensional problems, angular momentum, hydrogen atom; simple stationary state perturbation theory, perturbation of energy levels, Stark effect, normal Zeeman effect. I or II; 1 unit. Prerequisite: Physics 322 and 342; a course in atomic physics.

481. **Quantum Mechanics, II.** Principally applications to atomic and molecular structure. Electron spin; spin-orbit coupling, anomalous Zeeman effect; semi-classical treatment of emission and absorption of radiation with examples; selection rules, atomic spectra, X-ray spectra; Pauli principle, helium atom, exchange energy; periodic system of elements, Fermi-Thomas atom; diatomic molecules, electronic motion, vibrational and rotational motion, band spectra; simple collision problems, partial wave analysis, Born approximation. I or II; 1 unit. Prerequisite: Physics 480 or consent of instructor.

482. **Quantum Mechanics, III.** Formal structure of quantum theory; quantum theory of angular momentum, vector addition coefficients, simple tensor operators; collision problems, inelastic scattering, formal scattering theory; elementary treatment of quantization of the radiation field and the interaction of light with matter; introduction to Dirac electron theory. I or II; 1 unit. Prerequisite: Physics 481 and 422, or consent of instructor.

483. **Nuclear Physics.** Basic properties of nuclei; principles of high energy accelerators, particle and radiation detectors, and of precision measuring apparatus; alpha-, beta-, and gamma-decay of nuclei; nuclear masses and systematics of nuclei; nuclear models. I; 1 unit. Prerequisite: Physics 481.

484. **Nuclear Physics.** Nuclear reactions and nuclear models; fission; nuclear scattering and nuclear forces; high energy nuclear physics; meson produc-

tion and interactions; unstable heavy particles; electro-magnetic interactions. II; 1 unit. Prerequisite: Physics 483.

487. **Topics in Advanced Quantum Theory.** The following topics are offered alternately, but not every year.

(a) **Advanced Quantum Mechanics.** Relativistic quantum mechanics of a single particle, Dirac equation, Lorentz transformation, properties and bilinear covariants, bound state and scattering problems, Möller and Breit interactions, elementary radiation theory, relativistic photoeffect, bremsstrahlung, formal scattering theory, S-matrix, symmetry principles; I or II; 1 unit. Prerequisite: Physics 482.

(b) **Quantum Field Theory.** Field quantization; scalar and pseudoscalar meson field; electromagnetic field, Dirac field; interacting fields; electrodynamics; meson theory; interaction representation; s-matrix; covariant perturbation theory and Feynman diagrams; Compton scattering; Möller scattering; bremsstrahlung; pair annihilation; charge and mass renormalization; Lamb shift; anomalous electron magnetic moment; Heisenberg representation; dispersion relations; recent developments. I or II; 1 unit. Prerequisite: Physics 487a.

488. **Advanced Topics in Nuclear and Particle Physics.** The following topics are offered alternately, but not every year.

(a) **Nuclear Physics.** Nuclear forces, two nucleon problems, structure of light nuclei, nuclear models, interaction of electromagnetic radiation with nuclei, beta decay, theory of nuclear reactions, high energy nuclear interactions, properties of nuclear matter. I or II; 1 unit. Prerequisite: Physics 482 and 484, or consent of instructor.

(b) **Physics of Elementary Particles.** Empirical facts, phenomenological discussion of the production, scattering and absorption of pi mesons, theoretical models, K-mesons and hyperons, classification schemes for elementary particles and their strong interactions, particle-antiparticle phenomena, decay processes. I or II; 1 unit. Prerequisite: Physics 482 and 484, or consent of instructor.

489. **Theory of Solids.** Reviews the introductory phases of the modern theory of crystalline materials. Topics treated include the classical theory of ionic crystals, specific heats, electron theory of metals and semi-conductors, the band approximation. I; 1 unit. Prerequisite: Physics 360, 362, 381, or consent of instructor.

490. **Theory of Solids.** Continuation of Physics 489. The electronic structure of solids, optical and magnetic properties, crystal lattice imperfections, diffusion and ionic conductivity, cooperative phenomena, superconductivity. II; 1 unit. Prerequisite: Physics 489, or consent of instructor.

498. **Seminar.** A course number used for credit in individual but supervised study of a subject not covered by regular courses. I, II; 1 to 2 units.

499. **Thesis Research.** I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Basic Concepts of Physics.** Vectors: numerical integration of differential equations; classical mechanics of particles; relativity (special); electricity; quantum mechanics; statistical mechanics. I, II; ¾ unit. Prerequisite: College physics and introductory calculus.

321. **Theoretical Mechanics.** Laws of motion, vectors, statics, energy and momentum principles for a particle and for systems of particles, motion of a particle under constant forces, plane motion of a rigid body, simple harmonic motion and resonance, impact. Lectures and problems. Physics 321 and

322 are fundamental to many advanced courses, and should be elected as early as possible by those intending to specialize in physics. I, II; 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics and calculus.

322. **Theoretical Mechanics.** Continuation of Physics 321. Motion of a particle under a variable force, central field motion, accelerated reference systems, motion of a particle subject to constraints, rotation of a rigid body in three dimensions, vibrating systems and normal coordinates, generalized coordinates. I, II; 1 unit. Prerequisite: Physics 321.

341. **Electricity and Magnetism.** Fundamental laws logically developed and summarized in Maxwell's equations; forces and energies associated with electric and magnetic properties of matter; generation and propagation of electromagnetic waves. Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. I; ½ to 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics and calculus; registration in Mathematics 341 or 343, or consent of instructor.

342. **Electricity and Magnetism.** Continuation of Physics 341. Boundary conditions and special methods in boundary value problems; interpretation of dielectric and magnetic properties of matter from the point of view of atomic and crystalline properties; use of complex notation in circuit problems; coupled circuits; non-linear circuits, transmission lines; radiation from antennas; transmission and reflection of electromagnetic waves. II; ½ to 1 unit. No credit is given to graduate physics majors. Prerequisite: Physics 341.

343. **Electronic Circuits.** The physics of vacuum tube and semiconductor devices; theory and application of these devices as linear circuit elements in power supplies, amplifiers, communication circuits and control circuits. Emphasis is on experimental techniques. Lectures, problems, and laboratory. II; 1 unit. Prerequisite: Physics 341 or consent of instructor.

344. **Electronic Circuits.** Continuation of Physics 343. Electronic instruments and techniques used in research in physics and in digital computers; theory and experiments emphasizing the use and design of non-linear circuits, e.g., multivibrators, pulse generators, counters, etc.; theory of switching circuits; special topics. I; 1 unit. Prerequisite: Physics 343 or equivalent.

360. **Thermodynamics.** The first, second, and third laws of thermodynamics; the properties of the entropy, enthalpy, free energy, and internal energy functions; reversible and irreversible processes; applications to homogeneous and heterogeneous systems; chemical reactions and the mass action law. Lectures and problems. I, II; 1 unit. Prerequisite: General physics and calculus.

362. **Kinetic Theory and Statistics.** A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and applications. I, II; 1 unit. Prerequisite: Physics 360 or consent of instructor.

371. **Light.** Geometrical optics: image formation, thick lens theory, aberrations, photometry of optical systems, optical instruments; wave optics: interference and diffraction. Lectures, problems, and laboratory. I; ½ to 1 unit. Prerequisite: General physics and calculus.

372. **Light.** Continuation of Physics 371. Electromagnetic character of light, Maxwell's equations, theory of reflection and refraction, polarization, double

refraction, crystal optics, dispersion, scattering, optical properties of metals. II; ½ unit. Prerequisite: Physics 371.

374. **Light Laboratory.** To accompany Physics 372 and continue laboratory work of Physics 371. In addition to experiments related to topics of Physics 372, there are available a number of experiments in spectroscopic techniques and analysis. These include studies of the properties of photographic plates, chemical spectroscopic analysis, analysis of atomic and molecular spectra, Zeeman effect, Raman and fluorescence spectra. II; ½ unit. Prerequisite: Registration in Physics 372 or consent of instructor.

381. **Atomic Physics.** Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. The topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. I, II; 1 unit. Prerequisite: General physics and calculus; concurrent registration in Physics 385 is recommended.

382. **Nuclear Physics.** A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. II; 1 unit. Prerequisite: Physics 381 or 383.

383. **Atomic Physics and Quantum Theory for Engineers.** Introduces the student to the basic concepts of quantum theory which underlie modern theories of the properties of materials. Topics covered include elements of atomic and nuclear theory, kinetic and statistical theory, experimental basis of quantum theory, Schrödinger's equation and simple applications, atomic spectra and atomic structure, quantum states of molecules, band theory of solids, and quantum statistics. Lectures and problems. I, II; ¾ to 1 unit. Prerequisite: General physics; general chemistry; Mathematics 345 or equivalent.

385. **Introduction to Quantum Mechanics.** Experimental foundation; basic postulates; Schrödinger wave equation; hydrogen atom; superposition of states; the calculation of energy, position, momentum and angular momentum; steady state perturbation theory; identical particles, time-dependent perturbation theory; introduction to Dirac theory. The course emphasizes basic principles, applied to simple examples, many of them one-dimensional. Numerical methods for the solution of eigenvalue problems are used extensively. Recommended to physics majors and also to students in other physical sciences and engineering. I or II; 1 unit. Prerequisite: Registration in Physics 381; Mathematics 343, Mathematics 345, or consent of instructor.

PHYSIOLOGY

(Including Biophysics)

Graduate work in physiology is offered leading to the degrees of Master of Science and Doctor of Philosophy. Admission of beginning graduate students requires a grade-point average no lower than 3.5. There is no departmental requirement of specific undergraduate major or minor fields, but graduate students whose background is deficient in chemistry, physics, biological sciences, or mathematics must rectify these deficiencies early in their graduate careers.

Degree of Master of Science. To obtain the degree of Master of Science, the student must offer at least eight units of acceptable course work in physiology and related subjects. Ordinarily, the program includes Physiology 306 and 307, Advanced Mammalian Physiology; 361, Comparative Physiology; and 362, Cellular Physiology. During the semester when the candidate wishes to obtain the degree, he is examined in writing and orally by a departmental committee. The results of this general examination are taken into consideration by the committee in deciding whether or not he is certified for the degree, and whether or not he is accepted into the doctoral program of the Department of Physiology. No more than one unit of Physiology 481, Individual Topics, can be applied toward a master's degree; students offering Physiology 481 are expected to submit a term paper or brief research report to the adviser and the examining committee. Two units of Physiology 499, Thesis Research, and a thesis may be substituted for two units of course work.

Degree of Doctor of Philosophy. A student whose master's degree was obtained in the department is judged by his past record and by the results of the required written and oral examination. Transfer students whose master's degrees were obtained elsewhere are examined orally and in writing by the graduate committee toward the end of the first year of residence, and the results of this general examination determine in part whether or not they may continue toward the doctorate in this department. In their cases, this examination also determines what transfer credit is allowed toward the doctoral requirements for work completed elsewhere.

The department requires that the candidate pass a written comprehensive examination covering important areas of physiology before he is permitted to take his oral preliminary examination. Six papers are required: one each in general mammalian physiology, comparative physiology, and cellular physiology; one on his minor area; one on philosophy of science, history of biology, and biostatistics; and one on current physiological concepts related to his special area.

Each candidate must take, either as an undergraduate or a graduate student, the following courses or their equivalents: Physiology 306 and 307, Advanced Mammalian Physiology; 361, Comparative Physiology; 362, Cellular Physiology; 490, the department's introductory graduate course; Chemistry 340, Elementary Physical Chemistry; 350 and 355, General Biochemistry; Zoology 333, Vertebrate Embryology; 334, Vertebrate Histology; 351, Genetics.

In addition to satisfying the department's basic requirements for all students, each candidate specializes by following a program in one of the following areas: mammalian physiology, comparative physiology, cellular physiology, biophysics, endocrinology, neurophysiology, human anatomy and human physiology, bioclimatology, or radiobiology. An intra-departmental minor may be offered in most of these permissible areas of specialization, chosen from sequences other than Physiology 306, 307, 361, and 362. Details of the various specialized programs can be obtained at the departmental office, 524 Burrill Hall.

Minors. Graduate students majoring in other departments who wish to obtain a minor in physiology should see the head of the Physiology Department as early as possible in their graduate studies for discussion of a program and assignment of a departmental minor adviser. For a sole minor, a candidate from another department must offer four courses. For a first minor, three courses are required, two of which must include laboratory work. For a second or split minor, two laboratory courses are required. Courses recommended depend upon the needs of the individual student; usually, a sequence of courses within one area of physiology is desirable. Possible areas for sole and first minors are: cellular physiology (including radiobiology, electrobiology, and biophysics), comparative physiology, mammalian physiology, human anatomy and human physiology, endocrinology, neurophysiology, and bioclimatology.

GRADUATE TEACHING FACULTY

Professors: R. E. Johnson (Head of Department), C. L. Prosser, F. Sargent, F. R. Steggerda, A. B. Taylor, H. I. Teigler, G. J. Thomas.
Associate Professors: J. D. Anderson, H. S. Ducoff.
Assistant Professors: W. H. Johnson, S. G. Stolpe, D. C. Sutfin.

Physiology

COURSES FOR GRADUATES

401. **Mammalian Physiology Seminar.** Current trends in mammalian physiology. I or II; ½ unit. Prerequisite: Two semesters of mammalian physiology or equivalent; consent of instructor. Steggerda.

403. **Experimental Mammalian Physiology, I.** The physiological applications of experimental mammalian surgery. I, II; 1 unit. Prerequisite: Two semesters of advanced mammalian physiology or equivalent; consent of instructor. Steggerda.

404. **Experimental Mammalian Physiology, II.** The physiological applications of experimental pharmacodynamics. I or II; 1 unit. Prerequisite: Physiology 306 and 307, or equivalent; consent of instructor. Steggerda.

416. **Structure and Function of the Nervous System.** The understanding of nervous function through the experimental approach. II; 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. W. H. Johnson, Thomas.

421. **Gross Human Anatomy.** A general survey of the structures of the human body, with emphasis on the relations between form and function. I or II; 1 unit. Prerequisite: One semester of embryology; consent of instructor. Stolpe.

431. **Experimental Radiobiology.** Laboratory exercises in irradiation procedures and in the examination of biological responses to ionizing radiations. II; 1 unit. Ducoff.

441. **Fundamentals of Bioclimatology.** Same as Geography 441. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological and pathophysiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. I or II; ¾ unit. Prerequisite: Consent of instructor. Page, Sargent.

442. **Experimental Bioclimatology.** Same as Geography 442. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. I or II; ½ unit. Prerequisite: Physiology 306 and 307; credit or registration in Physiology 441. Page, Sargent.

443. **Advanced Human Bioclimatology.** Same as Geography 443. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. I or II; ½ unit. Prerequisite: Physiology 441. Page, Sargent.

450. **Human Pathologic Physiology.** Disturbances of function in tissues and organs, and their relationship to the pathogenesis of human disease. I or II; ¾ unit. Prerequisite: Physiology 306 and 307; Chemistry 350 and 355; consent of instructor. R. E. Johnson, Teigler.

451. **Human Pathologic Physiology Laboratory.** Laboratory methods for measuring the function of organs in the human. I or II; ½ unit. Prerequisite:

Credit or registration in Physiology 450; consent of instructor. R. E. JOHNSON, TEIGLER.

452. **Human Physiology Seminar.** Topics of current emphasis in human physiology. I or II; ½ unit. Prerequisite: Physiology 306 and 307; Chemistry 350 and 355; consent of instructor. R. E. JOHNSON, TEIGLER.

462. **Advanced General Physiology.** Same as Zoology 462. Seminar, lectures, student reports, discussions. I or II; ½ unit. Prerequisite: Consent of instructor. PROSSER.

470. **Advanced Cellular Physiology.** The functional organization of macromolecular systems in living cells, with emphasis on experimental techniques. I or II; 1 unit. Prerequisite: One year of general physics, calculus, and physical chemistry; Physiology 362. W. H. JOHNSON.

481. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. Not more than one unit in Physiology 481 may be offered toward a master's degree. I, II; ½ to 1 unit. Prerequisite: Approval of department. STAFF.

490. **Areas and Concepts of Physiology.** The general concepts and methodology of physiology in its various special fields. Required of all graduate majors in physiology during their first year of residence. I or II; ¼ unit. Prerequisite: Graduate major in physiology. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.
Research may be conducted in the following areas, with the consent of the instructor:

(a) **Cellular Physiology, Biophysics, Electrobiology, and Radiobiology.** ANDERSON, DUCOFF, W. H. JOHNSON, PROSSER, TAYLOR.
(b) **Comparative Physiology.** ANDERSON, PROSSER.
(c) **Mammalian Physiology.** STEGGERDA, SUTFIN.
(d) **Human Anatomy and Human Physiology.** R. E. JOHNSON, STOLPE, TAYLOR.
(e) **Endocrinology.** STOLPE.
(f) **Neurophysiology.** W. H. JOHNSON, THOMAS.
(g) **Bioclimatology.** SARGENT.
(h) **Environmental and Stress Physiology.** R. E. JOHNSON, SARGENT, STEGGERDA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Human Factors in Engineering for Space Travel.** Same as Aeronautical Engineering 304. Human factors decisive in the design and operation of manned space vehicles. I or II; ½ unit. Prerequisite: Senior or graduate standing in engineering, biology, psychology, or physical science.

306. **Advanced Mammalian Physiology.** The significance of muscle, nerve, blood, and circulation in mammalian physiology. I; 1 unit. Prerequisite: Courses totaling twenty hours in chemistry, animal biology, or both, beyond the introductory freshman courses; consent of instructor. STEGGERDA, SUTFIN.

307. **Advanced Mammalian Physiology.** The significance of respiration, digestion, metabolism, excretion, temperature regulation, and hormones in mammalian physiology. II; 1 unit. Prerequisite: Courses totaling twenty hours in chemistry, animal biology, or both, beyond the introductory freshman courses; consent of instructor. STEGGERDA, SUTFIN.

331. **General Radiobiology.** Response of multicellular organisms, cells, and macromolecules to ionizing radiations. Lectures, student reports, and discussions. I; 1 unit. Prerequisite: One year each of mathematics, physics, chemistry, and biology. DUCOFF.

350. Physiology of Physical Activity. A consideration of the efficiency of physical activity in humans as related to important factors such as training, temperature, altitude, and diet. II; ¾ unit. Prerequisite: Physiology 104 and 105, or equivalent; consent of instructor. R. E. Johnson.

361. Comparative Physiology. Same as Zoology 361. A comparison of the general physiology of different groups of animals. I; 1 unit. Prerequisite: Three semesters of animal biology; two semesters of chemistry. Anderson, Prosser.

362. Cellular Physiology. Same as Zoology 362. A physico-chemical analysis of biological functions common to most living cells. II; 1 unit. Prerequisite: Two semesters each of biology and general physics; three semesters of chemistry. Anderson, W. H. Johnson, Prosser.

363. Endocrinology. Same as Zoology 363. The glands of internal secretion with special reference to the vertebrates. I annually; II in 1960-1961 and in alternate years; 1 unit. Prerequisite: One semester of elementary zoology or physiology; Zoology 334 or organic chemistry. Hall.

Biophysics

The Biophysical Division of the Department of Physiology offers a curriculum leading to the degree of Doctor of Philosophy in Biophysics. The degree of Master of Science in Biophysics may be granted upon individual petition in special cases. The objective of the curriculum is to give the student sufficient training in physics, chemistry, and biology to enable him to use the conceptual, instrumental, and mathematical approach of the physical scientist in the solution of biological problems.

The curriculum is administered by a divisional committee consisting of faculty members from several departments, who have an active interest in biophysics. Research areas represented in this group include bioacoustics, cellular physiology, electrobiology, microbiology, molecular biology, physics of muscular contraction, photobiology (photosynthesis and related topics), and radiobiology. Students entering the curriculum may elect to do research in any of these areas. Those desiring further information should write to the Executive Secretary, Biophysical Division, Department of Physiology.

Admission. Admission requirements are one year of college biology, one year of college physics, quantitative analysis (five hours), organic chemistry (five hours), and calculus (six hours). Applicants must have a grade-point average of at least 3.75. Students with deficiencies in entrance requirements can be admitted upon approval of the Committee, but these deficiencies must be remedied as soon as possible in the course of graduate study, and no graduate credit is granted for this work.

Course Requirements. The curriculum is designed for two types of students, with undergraduate training predominantly in the physical sciences or predominantly in the biological sciences.

Students entering from undergraduate study of *physical sciences* may not always be able to meet the entrance requirements in biology; the rectification of these deficiencies in the first year of graduate study is required, because graduate courses in biology can not be taken profitably without proper background in general biology. Courses taken in an area of biology to rectify such deficiencies must be equivalent to courses acceptable for undergraduate majors in that area. On the other hand, students in this group can be expected to have taken, in their undergraduate study, not only all the courses in physical sciences required for entrance, but also most or all of the physics and chemistry courses listed below as minimum requirements for graduate study. In addition to the minimum require-

ments listed below, these students must take at least two additional units of study in advanced physics or chemistry, or both.

Students entering the curriculum from undergraduate study of *biological sciences* can be expected to have completed all entrance requirements in biology, but may have deficiencies in the requirements in physical sciences and mathematics. These requirements must be satisfied if possible in the first year of graduate study, since they constitute prerequisites for admission to advanced courses in physical sciences which students of this group have to take. Courses taken to rectify deficiencies must be equivalent to courses acceptable for undergraduate students majoring in physics. In order to obtain an understanding of the analytical methods and of the theoretical and experimental approach needed for biophysical work, these students are required to obtain before or during their graduate careers a knowledge of theoretical mechanics, electricity and magnetism, and atomic and molecular physics, as well as of physical chemistry. The courses listed below constitute minimal requirements in these areas, and students are urged, if at all possible, to take additional courses in advanced chemistry and physics.

General Course Requirements. Before taking the preliminary examination, admitting to Ph.D. candidacy, all students are required to take the following courses, or show equivalent credits.

(1) Mathematics, Physics, and Chemistry: Mathematics 343, Advanced Calculus, or Mathematics 345, Differential Equations and Orthogonal Functions; Physics 321, Theoretical Mechanics; Physics 341 and 342, Electricity and Magnetism; Physics 381, Atomic Physics; Chemistry 342, 343, 344, 345, Physical Chemistry (a one-year sequence including lectures and laboratory); Chemistry 350 and 355, Biochemistry. Certain of the required physics courses can be waived, upon approval of the Committee, in cases where the student has had comparable training in advanced courses in physical chemistry. A knowledge of colloidal and macromolecular phenomena equivalent to one semester of work comparable to Chemistry 346 is deemed necessary for work in biophysics.

(2) Biology: Zoology 351, Genetics, or Botany 322, Genetics; three units of graduate course work in one of the major areas of biology, determined by the research interests of the student. This last requirement is designed to acquaint the student with the problems confronting investigators in a selected area of biology, and courses should be chosen accordingly. The course in genetics can be included as part of the three-unit requirement in biology.

(3) Biophysics: Biophysics 401, The Biophysics of the Cell, or equivalent; Biophysics 402, Advanced Biophysics; Biophysics 403, Biophysical Techniques; one additional course in biophysics (other than research).

Other Requirements. The general Graduate College requirements listed earlier in this bulletin must be met by the student. The above described biophysics curriculum meets the requirements of the Graduate College with regard to major and minor subjects. Students entering from the biological sciences may, for example, declare a minor in physics or chemistry, or a minor in both, utilizing required courses in these fields, while students entering from the physical sciences may declare a sole minor in a selected field of biology. Other minors are possible but must meet Graduate College requirements and the approval of the Committee.

Minor. Subject to the approval of the Committee, candidates for the degree of Doctor of Philosophy in other fields may take a minor in biophysics. This minor must meet the general requirements of the Graduate College.

COURSES FOR GRADUATES

401. The Biophysics of the Cell. Topics included are molecular structure of the cell; cell dynamics, including material and energy balance and exchanges; specific functions of cells, such as motility, excitability, secretion, and others;

cell duplication. Laboratory work illustrates some of these topics by experiments on appropriate cell types. I; 1 unit. Prerequisite: One year of college physics, calculus, and physical chemistry; consent of instructor. STAFF.

402. **Advanced Biophysics.** Applications of the experimental and theoretical methods of physics to problems of biology, including the actions of electrical currents, electromagnetic radiations, high energy particles and radiations, and acoustical energy on biological systems; physical phenomena in biological materials, including action currents, photosynthesis, bioluminescence, and others. II; ¾ unit. One year of physics beyond introductory physics or equivalent, calculus, physical chemistry. STAFF.

403. **Biophysical Techniques.** This course is designed to acquaint the student with physical methods useful in the solution of biological problems. Topics covered are bioelectric measurements, including basic electronics; optical methods, including microscopy, spectrophotometry, and measurement of action spectra; use of high energy radiations; tracer techniques; acoustical techniques. II; ½ to 1 unit. Prerequisite: Credit or registration in Biophysics 402, or consent of instructor. STAFF.

410. **Special Topics in Biophysics.** An advanced course on some topic of interest in biophysics, such as electrobiology, radiation biology, photobiology, bioacoustics, or the physics of muscular contraction. I; ½ unit. Prerequisite: Biophysics 401 or equivalent; Biophysics 402 and 403.

411. **Seminar.** Survey of the literature in one area of biophysics, with special emphasis on student reports. II; ½ unit. Prerequisite: Enrollment in the biophysics program or consent of instructor.

499. **Thesis Research.** Research may be conducted in one of the areas listed below, subject to approval of the staff member concerned and the department in which the research is to be done. I, II; 0 to 4 units.
   (a) **Bioacoustics.**
   (b) **Cellular Physiology.**
   (c) **Electrobiology.**
   (d) **Microbiology.**
   (e) **Biophysics of Macromolecules.**
   (f) **Photosynthesis.**
   (g) **Physics of Muscular Contraction.**
   (h) **Radiobiology.**

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Biophysics.** A review of the field of biophysics designed to introduce the student to the types of biological problems currently under investigation in biophysical laboratories. I; ¼ unit. Prerequisite: Eight hours of physics or enrollment in the graduate biophysics program. STAFF.

PLANT PATHOLOGY

Students may choose a major, joint major, or minor in plant pathology. The following fields are available for specialization in plant pathology: diseases of field crops, forest and shade trees, fruit crops, ornamentals, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science degree must meet the general requirements of the Graduate College and must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination before a

committee of five staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy degree must meet the general requirements of the Graduate College regarding foreign languages, special examinations, minors, and theses.

Beginning graduate students are accepted with a grade-point average of 3.75.

GRADUATE TEACHING FACULTY

Professors: W. M. Bever (Head of Department), L. M. Black, J. C. Carter, J. W. Gerdemann, D. Gottlieb, M. B. Linford, M. B. Linn, D. Powell, H. H. Thornberry.

Associate Professor: A. L. Hooker.

Assistant Professor: D. W. Chamberlain.

COURSES FOR GRADUATES

401. **Diseases of Forest and Shade Trees.** A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. II; ½ to 1 unit. Prerequisite: Plant Pathology 301 or consent of instructor. Carter.

402. **Principles of Plant Disease Control.** An intensive study of the basic concepts of non-chemical and chemical methods used for the control of plant diseases. Lectures, discussions, and assigned reading and reports. II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Plant Pathology 301, elementary organic chemistry, or consent of instructor. Powell.

403. **Physiology of Fungi.** Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. I; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Organic or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

404. **Plant Virology.** Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, staining, assay, filtration, and purification; control methods; sources of information; history of virology. I; ½ to 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Consent of instructor. Thornberry.

417. **Discussions in Plant Pathology.** Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. I, II; ¼ unit. Staff.

499. **Thesis Research.** Individual study and research required of all students working toward the degree of Master of Science or Doctor of Philosophy in Plant Pathology. I, II; 0 to 4 units. Work can be taken in the following areas, subject to approval of the staff member concerned.

(a) Biochemistry of Plant Disease. Staff.
(b) Diseases of Corn; Genetics of Resistance. Hooker.
(c) Diseases of Cereal Grains. Bever.
(d) Diseases of Forest and Shade Trees. Carter.
(e) Diseases of Fruit Crops; Fungicides. Powell.
(f) Diseases of Leguminous Crops; Root Diseases. Gerdemann.
(g) Diseases of Soybeans. Chamberlain.
(h) Diseases of Vegetable and Canning Crops. Linn.
(i) Nematode Diseases. Linford.
(j) Physiology of Fungi; Antibiotics. Gottlieb.
(k) Plant Virology (same as Botany 499e). Black, Thornberry.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** For students desiring to study specific problems not assigned in other courses. I, II; ¼ to 1 unit; maximum accumulated credit, 2 units. STAFF.

301. **Plant Pathology.** Same as Botany 301. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. I; 1 unit. Prerequisite: One year of plant science, including Botany 100. BLACK.

302. **Research Methods in Plant Pathology.** Techniques for the isolation, identification, culture of and inoculation with plant pathogenes; methods for the histological study of diseased plants; recording of data. I; ¾ unit. Prerequisite: Plant Pathology 301; senior standing. GERDEMANN.

307. **Fruit Diseases.** Same as Horticulture 307. Symptomatology; life cycles, control measures; laboratory and field studies of representative diseases. II; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Plant Pathology 301 or Botany 372, or consent of instructor. POWELL.

308. **Vegetable and Canning Crop Diseases.** Same as Horticulture 308. Symptomatology; etiology, epiphytology, and control measures; laboratory and field studies of representative diseases. I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Plant Pathology 301 or Botany 372. LINN.

Botany 372. **General Mycology.** Structure, classification, and identification of fungi, including those of economic importance. Modification of the course is made to meet the needs of teachers and prospective teachers during the summer. II; 1 unit. Prerequisite: One year of botany, bacteriology, entomology, or zoology. ROGERS.

377. **Diseases of Field Crops.** Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. II; ½ unit. Prerequisite: Plant Pathology 301 or consent of instructor. HOOKER.

POLITICAL SCIENCE

The Department of Political Science offers graduate work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work is conducted in the following special fields: American government and politics, comparative government and politics, international law and relations, public administration, political theory and jurisprudence. A separate program leading to the degree of Master of Arts in Public Administration is administered by the department and is described in literature which will be furnished upon request directed to the department, 324 Lincoln Hall.

In order to be admitted to graduate work in political science a student must have a grade-point average of at least 3.75. He must also have had a minimum of twenty hours of undergraduate work in political science, economics, finance, sociology, or history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history). If a student making political science his major is taking both of his minors in other departments, one of them must be in history, economics, or sociology.

Several courses given in other departments are so closely related to those in political science that graduate students whose major is political science may be permitted on petition to take such courses as part of their major work. Attention is called to the courses in public law in the College of Law, the courses in public finance in the College of Commerce and Business Administration, the courses in city and regional planning in the College of Fine and Applied Arts, and the

courses in municipal and sanitary engineering in the College of Engineering. An extension curriculum in public administration leading to the Master of Arts degree is offered at Springfield, Illinois. This curriculum is designed particularly as in-service training for persons in the various state services.

Graduate students in other departments who choose political science as a minor must have had at least six hours of undergraduate work in political science and three hours in economics, sociology, or history.

GRADUATE TEACHING FACULTY

Professors: C. F. Snider (Chairman of Department), R. Dangerfield, M. Edelman, C. B. Hagan, V. Jobst, C. M. Kneier, E. G. Lewis, P. Monypenny, J. W. Peltason, J. A. Ranney, G. Y. Steiner, F. G. Wilson.
Associate Professors: N. F. Garvey, G. Manner, R. E. Scott.
Assistant Professors: R. L. Butwell, T. Page.
Instructors: D. J. Danelski, D. G. Sullivan.

COURSES FOR GRADUATES

400. **Classics of Political Science.** Reading, analysis, and discussion of leading works on politics and government. I or II; 1 unit. Staff.

401. **History of Political Theories.** Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. I; 1 unit. Wilson.

402. **History of Political Theories.** Reading and analysis of the leading political thinkers from the middle of the seventeenth century to the present. II; 1 unit. Wilson.

406. **Municipal Administration.** Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. I or II; 1 unit. Kneier.

410. **Problems in Rural Local Government.** Research in selected topics. I or II; 1 unit. Snider.

412. **Problems in State Government.** Research in selected topics in American state government. I or II; 1 unit. Snider.

420. **Formation of Public Policy.** Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. I or II; 1 unit. Hagan.

421. **Government and the Economic Order.** Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. I or II; 1 unit. Hagan.

423. **Politics of Labor Law.** Same as Labor and Industrial Relations 423. Labor's role in politics and as a pressure group; theories of labor policy formation; organization, procedures, and policy development in the administration of labor law; labor policy formation in the courts; labor's role in foreign political systems. I, II; 1 unit. Prerequisite: Consent of instructor. Edelman.

426. **Political Parties.** Special problems in political parties; methods and materials of research in this field. I or II; 1 unit. Ranney.

431. **Problems of British Government.** Special topics relating to British government. I or II; 1 unit. Lewis.

435. **Problems in the Government of the Soviet Union.** Special topics relating to the government of the Soviet Union. I or II; 1 unit. LEWIS.

440. **Comparative Politics and the Political Process.** The comparative study of selected national political systems or of specific institutional forces that influence the making and application of public policy in several countries. The countries studied and the legal and extra-legal political agencies considered vary according to the person conducting the seminar. I or II; 1 unit. This course may be repeated for credit not to exceed a total of three units. STAFF.

450. **Contemporary Governmental Problems.** Special problems of current importance. Designed especially for students not majoring in political science. S; 1 unit. STAFF.

451. **Constitutional Law.** Research in selected topics in the American constitutional system. I or II; 1 unit. Prerequisite: Political Science 351 or equivalent. PELTASON.

465. **Problems in Administrative Management.** An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. I or II; 1 unit. Prerequisite: Political Science 361 or 364, or consent of instructor. MONYPENNY, PAGE.

466. **Current Administrative Theory.** A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision-making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. I or II; 1 unit. MONYPENNY.

471. **Problems in International Organization.** Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. I or II; 1 unit. BUTWELL.

481. **Foreign Relations of the United States.** Special problems in the development and conduct of American foreign policy. I or II; 1 unit. SCOTT.

485. **International Law.** Research on selected topics. I or II; 1 unit. JOBST.

493. **Research in Selected Topics.** Research in selected topics by arrangement with the instructor. I, II; 1 unit. STAFF.

495. **Scope and Methods of Political Science.** Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; the present state of research in political science. I or II; 1 unit. MONYPENNY.

496. **Research Design and Techniques in Political Science.** Selection of research problems; research design; problems of sampling; data collection; measures of relationships; interpretation and reporting of results. I or II; 1 unit. Prerequisite: Political Science 495 or consent of instructor. SULLIVAN.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Municipal Government.** Growth of cities; their legal status; municipal politics and organization in the United States. I; ½ to 1 unit. KNEIER.

306. **Municipal Problems.** Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning

and housing; police and fire administration; public health; public utilities. II; ½ to 1 unit. KNEIER.

310. **Rural Local Government.** Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. I or II; ½ to 1 unit. SNIDER.

312. **State Government.** The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; reorganization problems in the state; state-local relations; state finance; trends and prospects. Students do not receive credit for both Political Science 110 and 312. I or II; ½ to 1 unit. SNIDER.

315. **Legislatures and Legislation.** The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reorganization. I or II; ½ to 1 unit. HAGAN.

317. **The American Federal System.** The nature, justification, and problems of federalism; coordination of governmental efforts by contract, subsidies, and grants; comparison of federal systems. I or II; ½ to 1 unit. STEINER.

321. **Government and the Economic Order.** A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. I; ½ to 1 unit. HAGAN.

325. **Political Parties: Historical Development and Issues.** Nature of American party system; historical development of parties and issues; third or minor parties and their role. I or II; ½ to 1 unit. RANNEY.

326. **Political Parties: Organization and Methods.** Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. I or II; ½ to 1 unit. RANNEY.

328. **Political Behavior: The Electoral Process.** A study of the principal characteristics of and influences upon voting behavior in the United States; methods for studying voting behavior and predicting elections; analysis of present alignments in the electorate as revealed by recent elections. I or II; ½ to 1 unit. SULLIVAN.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. I or II; ½ to 1 unit. LEWIS.

335. **Government and Politics of the Soviet Union.** Evolution, structure, and functioning of the Soviet system of government; the theories, structure, and functioning of the Communist party of the Soviet Union; satellites and external relations of the U.S.S.R. Students do not receive credit for both Political Science 335 and 346. I or II; ½ to 1 unit. LEWIS.

336. **Governments and Politics in Western Continental Europe.** An analysis of the major governmental systems of Continental Europe; the evolution, structure, and functioning of the political institutions of France, Germany, Italy, Spain, Switzerland, and the Scandinavian countries as illustrations of multiparty and dictatorial types of governments. I or II; ½ unit. LEWIS.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin-American political institutions; systems of government;

public administrative systems; party government; international policies of Latin-American governments. I or II; ½ to 1 unit. SCOTT.

343. **International Relations of Latin America.** Latin-American position and objectives in international affairs, with emphasis on the Latin-American viewpoint; the Monroe Doctrine; the Good Neighbor Policy; the Organization of American States and the United Nations; recent relations of specific nations. I or II; ½ to 1 unit. SCOTT.

345. **Theory and Practice of Democratic Government.** Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. I or II; ½ to 1 unit. RANNEY.

346. **Theory and Practice of Communism.** A survey of the international Communist movement. The origins of modern communism and the nineteenth-century development of its doctrines; the Russian Revolution; Lenin and Stalin; the U.S.S.R. as a model for communism; the regional development of Communist parties. Students do not receive credit for both Political Science 346 and 335 or 396. I or II; ½ to 1 unit. WILSON.

347. **Governments and Politics of South and Southeast Asia.** A comparative analysis of the governments and politics of India, Pakistan, Ceylon, and the countries of Southeast Asia; their international relations and foreign policies, traditional as well as contemporary forms of political behavior; nationalism and communism as political forces. I or II; ½ to 1 unit. BUTWELL.

348. **Governments and Politics of East Asia.** A comparative analysis of the governments and politics of China, Japan, and Korea; their international relations and foreign policies; traditional as well as contemporary forms of political behavior; nationalism and communism as political forces. I or II; ½ to 1 unit. BUTWELL.

351. **American Constitutional System.** Judicial interpretation of the constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. I; ½ to 1 unit. DANELSKI, PELTASON.

355. **The Constitution and Civil Liberties.** A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. I or II; ½ to 1 unit. DANELSKI, PELTASON.

356. **Public Administration and the Judicial Process.** The scope of administrative powers and their relation to private rights. A comparison of the processes of decision in administrative agencies and in the courts; the interests served by each; the impact of judicial review of administrative decisions upon administrative procedure and policy; the constitutional and statutory bases of review; the legal accountability of public officers versus political accountability. II; ½ to 1 unit. MONYPENNY.

359. **Jurisprudence.** Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. I or II; ½ to 1 unit. MANNER.

361. **Introduction to Public Administration.** Development of administrative organizations; administration and the executive, legislative, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. I; ½ to 1 unit. MONYPENNY.

362. **Administrative Organization and Policy Development.** Dynamics of policy formulation in public administrative agencies; current developments in

organizational theory and their significance for public administration; origin of public administrative organizations; interpersonal behavior; large-scale organizations and centralization; external support and opposition; policy formation and problems of compliance. I or II; ½ to 1 unit. Prerequisite: Political Science 361 or consent of instructor. EDELMAN.

365. **Government and Labor.** Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. I or II; ½ to 1 unit. EDELMAN.

367. **Public Fiscal Administration.** The public budget process in representative governmental units; preparation and control, the budget as a tool of policy, audit functions, supply services, claim settlement, fund and debt management, relation to organization and methods analysis and personnel utilization, and intergovernmental fiscal relations. I or II; ½ to 1 unit. PAGE.

368. **Public Personnel Administration.** Same as Labor and Industrial Relations 368. An analysis of personnel management in government. Recruitment and selection, job and salary classification, work standards, training, and the role of labor and professional organizations in the public services are considered in the light of current theory and practice. I or II; ½ to 1 unit. PAGE.

371. **World International Organization.** General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the United Nations and related agencies and to their evolution from the League of Nations system. I or II; ½ to 1 unit. BUTWELL.

372. **Regional International Organizations.** Descriptive and comparative analysis of various regional international organizations, their role in contemporary politics and their relationship to the United Nations system; structure, functions, and accomplishments of North Atlantic Treaty Organization, Southeast Asian Treaty Organization, Organization of American States, and other regional international organizations. I or II; ½ to 1 unit. BUTWELL.

381. **American Foreign Relations.** Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty-making power; development of foreign policy. I or II; ½ to 1 unit. SCOTT.

382. **Contemporary American Foreign Policies.** Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. I or II; ½ to 1 unit. DANGERFIELD, SCOTT.

384. **International Relations.** An examination of the nature of the national state system, of the forces affecting international relations, of the sources of conflicts in international politics, and of their solution by power politics or by international cooperation. Students do not receive credit for both Political Science 384 and 184. I or II; ½ to 1 unit. MANNER.

385. **International Law.** Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. I; ½ to 1 unit. JOBST.

386. **International Law.** Responsibility, intercourse, and redress of differences between states. II; ½ to 1 unit. JOBST.

393. **History of Political Theory.** A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of Christian political thought and the Middle Ages; political

theory during the Renaissance, Reformation, and the Counter-Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, Utopianism, and socialism. I or II; ½ to 1 unit. WILSON.

396. **Contemporary Political Theory.** Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; anti-democratic thought and totalitarian regimes. Students do not receive credit for both Political Science 396 and 346. I or II; ½ to 1 unit. WILSON.

397. **American Political Theory.** A survey of American political thought from colonial times to the present. I; ½ to 1 unit. Offered in 1961-1962 and in alternate years. WILSON.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Fields. Doctoral programs are offered in the following special areas of psychology: general experimental psychology, personality, social psychology, psychological measurement, clinical and counseling psychology, engineering psychology, industrial psychology, school psychology.

Admission. The candidate must meet the following departmental requirements: (1) a minimum of fifteen semester hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) a one-year course in another laboratory science; (4) a grade-point average of at least 4.0. Preference is given to students who have taken college mathematics and two years of French, Russian, or German. Because it is necessary to limit admissions to graduate study in psychology, it is not possible to accept all applicants who meet the minimal requirements.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The degree of Master of Arts is awarded to candidates who complete satisfactorily eight units of course work and present an acceptable thesis.

All first-year graduate students in psychology must take Psychology 403 and 404 and, if not completed earlier, Psychology 306 and 307. The doctoral candidate must also complete an approved program of courses in his area of specialization.

In the fields of clinical and counseling psychology, and school psychology, the doctoral candidate must also complete the equivalent of a full-time academic year of internship in an agency approved by the Department of Psychology.

TRAINEESHIPS

United States Public Health Service Traineeships in Measurement and Clinical Psychology. Graduate students, including first-year applicants, are automatically considered for these appointments. No application is necessary. Current stipends (tax-free) are: Level 1, $1,800; Level II, $2,000; Level III, $2,400; Level IV, $2,800. The trainee has no duties other than full-time graduate work.

Veterans Administration Traineeships in Clinical and in Counseling Psychology. First-year students are not eligible for these appointments. Applicants for advanced standing may apply for a traineeship by a letter addressed to the head of the Department of Psychology. The trainee works approximately half-time in a Veterans Administration hospital as a Civil Service appointee.

GRADUATE TEACHING FACULTY

Professors: L. G. Humphreys (Head of Department), R. B. Cattell, L. J. Cronbach, C. W. Eriksen, T. N. Ewing, W. M. Gilbert, G. R. Grice, L. A. Hellmer, J. M. Hunt, W. E. Kappauf, L. H. Lanier, O. H. Mowrer, L. I. O'Kelly, C. E. Osgood, L. Stolurow.

Associate Professors: J. A. Adams, J. Cohen, D. E. Dulany, F. E. Fiedler, H. W. Hake, Alice K. Jonietz, W. G. McAllister, W. J. McGuire, J. C. Nunnally, D. R. Peterson, H. Rosen, I. D. Steiner.

Assistant Professors: S. Alexander, W. C. Becker, N. H. Eisen, R. Frankmann, G. R. LaForge, P. London, D. T. Shannon, D. J. Shoemaker, H. W. Sinaiko, S. Stark, H. C. Triandis, M. Wagman.

COURSES FOR GRADUATES

The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all of the prerequisites.

401. **History of Psychology.** I or II; 1 unit. Prerequisite: Twelve hours of psychology. Grice.

402. **Systematic Psychology.** A critical analysis and comparison of modern and contemporary psychological systems. I or II; 1 unit. Prerequisite: Twelve hours of psychology.

403. **Proseminar in General Psychology, I.** A brief historical introduction to modern psychology; fundamentals of differential psychology, including the measurement of intelligence, aptitudes, and personality; motivation, emotion, and mechanisms of defense; psychological development; social behavior. I; 1 unit. Prerequisite: Twelve hours of psychology.

404. **Proseminar in General Psychology, II.** Sensory processes; perception; fundamental processes in learning; learning theory; special aspects of human learning; language behavior; thinking; logical aspects of psychological theory. II; 1 unit. Prerequisite: Twelve hours of psychology.

408. **Design of Experiments in Psychology.** Advanced experimental designs in psychological research; special methods of data analysis. I or II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Psychology 307. Kappauf.

409. **Psychological Scaling.** Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. I or II; 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Psychology 307.

411. **Advanced Physiological Psychology.** Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation, learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. O'Kelly.

415. **Experimental Sensory Psychology.** A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. I or II; 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. Kappauf.

416. **Perception.** Systematic study of methods and research findings in the field of human perception, together with an evaluation of theoretical interpreta-

tions. I, II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Twelve hours of psychology. HAKE.

417. **Experimental Psychology of Learning, I: Basic Processes.** A study of experimental investigation of basic learning processes with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. I; 1 unit. Prerequisite: Twelve hours of psychology. GRICE.

418. **Experimental Psychology of Learning, II: Human Learning.** Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. II; 1 unit. Prerequisite: Psychology 417 or consent of instructor. ADAMS.

419. **Advanced Comparative Psychology.** A critical examination of specific techniques used and of representative results obtained in the study of animal behavior. Laboratory demonstrations and individual research problems. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 345 or equivalent. MCALLISTER.

421. **Problems in Motivation.** I or II; 1 unit. Prerequisite: Twelve hours of psychology.

425. **Psycholinguistics.** Same as Communications 425 and Humanities 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. I or II; 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. **Research Seminar in Psycholinguistics.** Same as Communications 426 and Humanities 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. I or II; ½ to 1 unit. Prerequisite: Psychology 425.

427. **Engineering Psychology.** Experimental psychology applied to the study of man-machine interrelationships; psychological factors in the design of communication and control equipment. I, II; 1 unit. Prerequisite: A laboratory course in experimental psychology or equivalent. HAKE.

428. **Higher Processes.** An examination of method, theory, and research in the study of thinking; status of cognition as a construct; verbal control of behavior; concepts, problem solving, attention, language and thought; cognitive process as a source of motivation. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology.

431. **Psychological Measurement in Industry.** Application of psychometric methods and the findings of differential psychology to the selection, classification, and performance evaluation of industrial personnel. I or II; 1 unit. Prerequisite: Psychology 307 or equivalent.

435. **Motivation and Morale in Industry.** Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. I or II; 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. ROSEN.

442. **Behavior Disorders.** A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. II; 1 unit. Prerequisite: Psychology 338 and 403. PETERSON.

443. **Psychodiagnostics, I.** Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and

achievement. I; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 290 or equivalent. BECKER, SHANNON.

444. **Psychodiagnostics, II.** Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. II; 1 unit. Prerequisite: Psychology 443; consent of instructor. BECKER, SHANNON.

445. **Psychodiagnostics and Psychotherapy, I.** Provides didactic training and supervised experience in psychodiagnostics and psychotherapy. Students are required to enroll concurrently in Psychology 463-464, as a means of relating the practicum experience with the study of research methodology. I; 1 unit. Prerequisite: Six units of graduate credit in psychology, including Psychology 442, 443, and 444; consent of instructor. GILBERT, HELLMER, JONIETZ, SHANNON, SHOEMAKER.

446. **Psychodiagnostics and Psychotherapy, II.** Continuation of Psychology 445. II; 1 unit. Prerequisite: Psychology 445; consent of instructor. GILBERT, HELLMER, JONIETZ, SHANNON, SHOEMAKER.

451. **Advanced Social Psychology.** A systematic and critical treatment of individual behavior variables in relation to group variables. I or II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 255 or equivalent. STEINER.

456. **Psychology of Social Communication.** Same as Communications 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. I or II; 1 unit. Prerequisite: Psychology 451 or equivalent, or consent of instructor. MCGUIRE.

457. **Social Perception and Interpersonal Relations.** The genesis and development of social perception, with emphasis upon the concept of the "self" and its role in social perception; motivational factors in social perception; interpersonal perception, and its effects upon individual and group behavior. I or II; 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Psychology 451 or equivalent. FIEDLER.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision-making, group cohesiveness, and productivity. I or II; 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Six units of graduate credit in psychology, including Psychology 451 or equivalent. STEINER.

459. **Leadership and Group Effectiveness.** Theories of leadership; methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. I or II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Psychology 451 or equivalent. FIEDLER.

461. **Developmental Psychology.** Theory and research on psychological development from birth through adolescence; maturation of behavior systems; the role of social learning in development; the effects of early experience on personality development; critical stages in development. I or II; 1 unit. Prerequisite: Twelve hours of psychology or consent of instructor. HUNT.

462. **Human Abilities.** Analysis of individual differences in human abilities, including historical background, measurement methodology, and functional correlates of abilities. The use of ability measures in both experimental and applied research is considered. Offered in 1961-1962 and in alternate years. I or II; 1 unit. Prerequisite: Psychology 307 or equivalent. HUMPHREYS.

463. **Research Methods in Clinical Psychology and Personality, I.** The logical

analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. I; ½ unit. Prerequisite: Psychology 307, 403, and 444. ERIKSEN, HUNT.

464. **Research Methods in Clinical Psychology and Personality, II.** Continuation of Psychology 463. II; ½ unit. Prerequisite: Psychology 463. ERIKSEN, HUNT.

466. **Test Construction.** A laboratory course in the construction and evaluation of psychological tests. I or II; 1 unit. Prerequisite: Psychology 495; Psychology 462 or 467. HUMPHREYS, NUNNALLY.

467. **Personality Assessment.** Methods and theory in the quantitative assessment of personality; review of research findings and trends. Offered in 1960-1961 and in alternate years. I or II; 1 unit. Prerequisite: Psychology 307 or equivalent. BECKER.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories concerning the learning process, including the work of Hull, Tolman, and Guthrie. I or II; 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. GRICE.

490. **Individual Research.** For graduate students who wish to conduct research on special problems not included in graduate theses. I, II; ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

492. **Psychology of Learning and Instruction.** Same as Education 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. I; 1 unit. Prerequisite: Psychology 331 or 348.

493. **Seminar.** Discussion of current topics in their historical setting, with special emphasis on research problems. I, II; ½ to 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. STAFF.

494. **Multivariate Analysis in Psychology.** The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multi-dimensional scaling. I or II; 1 unit. Prerequisite: Psychology 307 or Education 496; consent of instructor. NUNNALLY.

495. **Theory of Measurement.** Same as Education 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. I; 1 unit. Prerequisite: Education 496 or Psychology 307; Education 392 or Psychology 290, or equivalent. CRONBACH, HASTINGS, KAISER.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Quantitative Methods, I.** A lecture and laboratory course in the development and application of quantitative methods in psychological research. I, II; 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. HAKE, KAPPAUF.

307. **Quantitative Methods, II.** Continuation of Psychology 306. I, II; 1 unit. Prerequisite: Psychology 306. HUMPHREYS, KAPPAUF.

311. **Physiological Psychology.** A study of the physiological basis of behavior, including sensory processes, motivation, emotion, learning, and intelligence. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology; Physiology 103 or 106, or Zoology 101. O'Kelly.

326. **Motivation and Emotion.** The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology.

330. **Experimental Psychology, I.** A survey of problems, experimental methods, and research findings in the fields of psychophysics, sensory processes, perception, judgment, and thinking. I; ½ to 1 unit. Prerequisite: Psychology 100 or 103; a course in statistics. Hake.

331. **Experimental Psychology, II.** A survey of problems, experimental methods, and research findings in the fields of motivation, learning, retention, and work. Credit is not allowed for both Psychology 331 and 348. II; ½ to 1 unit. Prerequisite: Psychology 100 or 103; a course in statistics. Grice.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. I, II; ½ to 1 unit. Prerequisite: Six hours of psychology. Becker, Peterson.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. I or II; ½ to 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. McAllister.

348. **The Psychology of Learning.** A survey of the basic facts and theories of the learning process. Credit is not allowed for both Psychology 331 and 348. I or II; ½ to 1 unit. Prerequisite: Six hours of psychology.

355. **Industrial Social Psychology.** Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid in understanding and analyzing industrial problems. I or II; ½ to 1 unit. Prerequisite: Psychology 255 or 357.

356. **Human Factors in Equipment Design.** The contributions of psychological research to the design of equipment for efficient human use and operation. Studies of the characteristics and limitations of the human individual which bear upon the equipment and machines best suited to his use. A survey of research on visual and auditory displays, controls, layout of consoles; complex man-machine systems; vigilance and isolation effects; design for efficient trouble-shooting and maintenance. Emphasis is placed upon the methods used in collecting data on these problems. Applications to engineering, industrial design, management, etc. are discussed. I or II; ½ to 1 unit. Prerequisite: Psychology 100 or 103, or Division of General Studies 171 and one course in statistics or college mathematics.

357. **Psychology of Industrial Conflict.** Same as Labor and Industrial Relations 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. Offered in special interest of industrial relations, commerce, and engineering students. Should not be taken by honors or graduate majors in psychology. I, II; ½ to 1 unit. Prerequisite: Psychology 100 or equivalent. Stark.

358. **Human Performance in Man-Machine Systems.** Examination of equipment and training variables that influence the human operator and the effectiveness of man-machine systems; methods of task analysis for the systematic determination of behavioral requirements; design and use of simulators and other training devices; measurement of operator proficiency; control and display

variables in closed-loop tracking systems; motor and perceptual fatigue; effect of work load; contemporary issues. Field trips. Research project on equipment design. I or II; ½ to 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics.

360. **Modern Viewpoints in Psychology.** A brief survey of early theoretical psychology followed by an examination of contemporary "behavior theory," Gestalt theory, and psychoanalytic theory — as conceptions of man and as approaches to the study of learning, perception, personality, and social behavior. I, II; ½ to 1 unit. Prerequisite: Senior standing; nine hours of psychology with an average grade of B, or consent of instructor. DULANY.

RADIO AND TELEVISION

The Department of Radio and Television offers graduate work leading to two advanced degrees, the Master of Science in Radio and Television and the Master of Television. For the program leading to the Doctor of Philosophy degree in Communications, see page 105.

Admission to the program leading to the Master of Science degree requires: (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in radio-television or a related field, English, or the social sciences; (2) a grade-point average of at least 3.75.

Admission to the program leading to the Master of Television degree requires: (1) meeting minimum requirements for admission to the Graduate College; (2) a bachelor's degree from an accredited institution, ordinarily with a major in radio, television, theater arts, journalism, or some other area related to television; (3) the approval of an entrance committee.

Degree of Master of Science in Radio and Television. Requirements for this degree include:

(1) A major of four units or three units and one additional unit approved by the adviser. Candidates must select either Radio-Television 462 or Journalism 471. Candidates without acceptable undergraduate majors are required to complete Radio-Television 252 (Television Laboratory), 368, and Advertising 386.

(2) A minor of at least two units, normally in an area outside the College of Journalism and Communications.

(3) A thesis of one or two units.

(4) A minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

Degree of Master of Television. This program provides professional training for persons who expect to go into non-engineering areas of television. It differs from the Master of Science program in these ways: it does not require a thesis, but instead requires study in special problems of television; it does not require a minor, but permits concentration in the fifth year in the radio and television field.

Requirements for the degree include a total of eight units of credit, with a minimum of six units selected from courses in the television sequence. The following courses must be included among these six units if they or their equivalents have not been completed on the undergraduate level: Radio-Television 462, one unit; Radio-Television 450, two units; Radio-Television 368, one-half unit, and Advertising 386, one-half unit. Candidates without undergraduate training acceptable for the program are required to complete the following undergraduate courses: Radio-Television 252 (Television Laboratory) and Radio-Television 261 (Principles of Radio and Television Broadcasting); but under exceptional cir-

cumstances, such as professional experience in television broadcasting, this requirement may be waived.

Students are expected to plan their programs around a special interest area. These areas of special interest include television production and direction, television writing, television news, television advertising, cinematography for television, television art, and television scenic design.

GRADUATE TEACHING FACULTY

Associate Professors: H. V. Cordier (Head of Department), D. E. Brown, F. E. Schooley.
Instructors: A. Fiering, H. W. Lippold, Jr.
Lecturer: H. J. Skornia.

COURSES FOR GRADUATES

450. **Special Problems in Television.** Project work for advanced students in specific areas of television, including news, advertising, directing, writing, etc. I, II; 1 to 2 units. Students may reregister for this course up to a total of four units. Prerequisite: A television course in the area of specialization; consent of instructor.

451. **Television Program Management and Production.** Problems in originating, planning, and producing television programs. II; 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor. Cordier.

462. **Seminar in Radio and Television.** Same as Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. I; 1 unit. Skornia.

490. **Special Topics in Radio and Television.** I, II; ½ to 1 unit. Prerequisite: Consent of head of department. Staff.

499. **Thesis Research.** I, II; 1 to 2 units. Prerequisite: Graduate standing in radio-television. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

353. **Television Script Writing.** General principles of writing for television, including all nondramatic and dramatic forms. II; ½ unit. Prerequisite: Radio-Television 252; consent of instructor. Cordier.

354. **Television Directing.** The theory and techniques of directing the television program. Experience in directing laboratory productions. I, II; ½ unit. Prerequisite: Radio-Television 252; consent of instructor. Cordier.

355. **Television News.** News coverage, script preparation, use of visual materials, and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. I, II; ½ unit. Prerequisite: Consent of instructor. Lippold.

356. **Cinematography for Television.** The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. I, II; ½ unit. Prerequisite: Consent of instructor. Fiering.

357. **Television Staging and Lighting.** The theory and practice of staging and lighting for television. II; ½ unit. Prerequisite: Radio-Television 252.

362. **Radio and Television Station Management.** A study of the organization and

administration of the radio and television staff and station; public relations, personnel management, and station operation; analysis of station and agency relationships and radio and television sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. I; ½ unit. Prerequisite: Radio-Television 261. SCHOOLEY.

365. **Radio News.** News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. I, II; ½ unit. Prerequisite: Journalism 211. BROWN.

366. **Advanced Radio and Television Practices, I.** Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. I; ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. **Advanced Radio and Television Practices, II.** Continuation of Journalism 366. II; ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. **Radio and Television Regulation.** Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. II; ½ unit. SCHOOLEY.

RECREATION

The Department of Recreation offers a program of graduate study leading to the degree of Master of Science in Recreation. This program is centered in training leaders, supervisors, administrators, teachers, and research workers in community recreation, but also offers opportunities for training in the related fields of recreation for the ill and handicapped, parks management, voluntary youth services, and specialization in given program areas of recreation such as sports, music, dramatics, arts and crafts, camping, outdoor education, and the like.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate credit in the natural sciences; and (5) a course in statistics or tests and measurements.

Graduation requirements for this degree are eight units including (1) four units of credit in approved courses to be chosen in the following areas: recreation, education, political science, psychology, social work, and sociology; (2) two units of approved electives to be chosen in the following areas: art, botany, geology, health education, landscape architecture, literature, music, physical education, speech, and zoology; (3) registration in and satisfactory completion of Recreation 490, without credit; (4) presentation of an acceptable thesis in recreation, two units. The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in recreation may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

GRADUATE TEACHING FACULTY

Professors: C. K. BRIGHTBILL (Head of Department), A. V. SAPORA.
Assistant Professor: H. E. WEAVER.

COURSES FOR GRADUATES

401. **Foundations of Recreation.** Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. I or II; 1 unit. Prerequisite: Recreation 176 or equivalent. BRIGHTBILL.

402. **Recreation Administration.** Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. I, II; 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent. BRIGHTBILL.

403. **Evaluation of Recreation Resources and Programs.** Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; and research in the field of recreation. I or II; 1 unit. Prerequisite: Recreation 176 or 375 or equivalent; a course in tests and measurements or statistics. SAPORA.

404. **Outdoor Education and Recreation.** Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. II; 1 unit. Prerequisite: Recreation 174 or equivalent; one undergraduate course in biology, botany, geology, or zoology. WEAVER.

490. **Seminar.** Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. I, II; no credit. STAFF.

493. **Special Projects.** Independent research on special projects. Open only to students majoring in recreation. I, II; ½ to 2 units. Prerequisite: Recreation 403 or equivalent. STAFF.

499. **Thesis Research.** Preparation of theses in recreation. I, II; ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

375. **Organization of Recreation Programs.** Organization of public and private agency programs, leadership, facilities and services, and introduction to recreation administration. I, II; ½ unit. Prerequisite: Recreation 176. SAPORA.

RUSSIAN

The Department of Russian offers graduate work leading to the degree of Master of Arts.

Students with a minimum grade-point average of 4.0 are regularly admitted to graduate courses in Russian, subject to fulfillment of other prerequisites. Students with a grade-point average between 3.5 and 3.99 are admitted upon approval of the department.

Students electing Russian as a major subject should have had the equivalent of at least four years of Russian in college, including practical work in the use of the language and an advanced course in literature.

Students choosing Russian as a minor subject should consult the department.

In addition to fulfilling the general requirements of the Graduate College, candidates for the degree of Master of Arts in Russian must pass an examination based on a general reading list.

GRADUATE TEACHING FACULTY

Professor: R. E. Matlaw (Head of Department).
Associate Professor: Frances F. Sobotka.
Assistant Professor: Tatjana Cizevska.

COURSES FOR GRADUATES

400. **Beginning Russian for Graduate Students.** Basic grammar and vocabulary, introduction to the reading of Russian texts in the sciences and the humanities. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. degree. I, II; 4 hours. No graduate credit. Cizevska.

401. **Readings in Russian for Graduate Students.** Grammar, vocabulary, general and special readings. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. degree. I, II; 4 hours. No graduate credit. Prerequisite: Russian 400 or equivalent. Cizevska.

405. **Church Slavonic.** Analysis of grammar, reading of texts, discussion of development of the Slavic languages. I or II; 1 unit. Cizevska.

407. **Advanced Russian Syntax.** Theoretical and practical study of present-day Russian. Training in free composition and translation into Russian. I or II; 1 unit.

410. **Literature of the Eleventh to the Sixteenth Centuries.** Reading of texts. Historical and literary background of the period. I or II; 1 unit. Cizevska.

412. **Literature of the Seventeenth and Eighteenth Centuries.** Reading of texts. Historical and literary background of the period. II; 1 unit.

414. **Studies in Russian Poetry.** Versification, poetic structure, problems of imagery and meaning. Practical work in interpretation and appreciation of individual poems of the eighteenth to the twentieth centuries. I or II; 1 unit. Sobotka.

491. **Individual Topics.** I, II; ¼ to 3 units. Prerequisite: Graduate standing with a major or minor in Russian.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Specialized Russian Reading.** Supervised individual reading programs. Designed for students majoring or minoring in Russian, or who desire to achieve competence in reading Russian for other subject fields. II; 1 unit. Prerequisite: Russian 104 or equivalent, or consent of instructor. Sobotka.

308. **Russian Phonetics and Diction.** Theoretical and practical work on pronunciation and intonation in Russian, with special attention to the problems of teachers. II; 1 unit. Prerequisite: Russian 212 or consent of instructor.

309. **Russian Literature in Translation, I.** Survey of Russian literature from the end of the eighteenth century to Dostoyevski; cultural and historical background of the period. No knowledge of Russian language is required. I; ¾ unit.

310. **Russian Literature in Translation, II.** Survey of Russian literature from Dostoyevski to the present day; cultural and historical background of the period. No knowledge of Russian language is required. II; ¾ unit.

321. **Readings in Russian Literature: Pushkin, Lermontov, Gogol.** Representative works of the period 1820-1850. Historical and cultural backgrounds. I; ¾ to 1 unit. Prerequisite: Russian 104 or consent of instructor. Sobotka.

322. **Readings in Russian Literature: Turgenev, Tolstoy, Dostoyevski.** Representative works of the period 1850-1880. Historical and cultural backgrounds. II; ¾ to 1 unit. Prerequisite: Russian 321 or consent of instructor.

323. **Readings in Russian Literature: Goncharov, Ostrovsky, Tolstoy.** Representative novels and plays of the later nineteenth century. Historical and cultural backgrounds. I; ¾ to 1 unit. Prerequisite: Russian 104 or consent of instructor.

324. **Readings in Russian Literature: Chekhov, Gorky.** Representative novels and plays of the period 1886-1917. Historical and cultural backgrounds. The final weeks of the course are an introduction to contemporary literature. II; ¾ to 1 unit. Prerequisite: Russian 323 or consent of instructor. SOBOTKA.

RUSSIAN LANGUAGE AND AREA STUDIES

Graduate minors in Russian Language and Area Studies are offered by the Division of Social Sciences.

Minor for the Master's Degree. A candidate for the master's degree who elects Russian Area Studies as a minor must earn at least two units of graduate credit in courses chosen from the following: Anthropology 381, 382; Economics 312; Geography 353, 495; History 327, 328, 419, 420; Political Science 335, 435; Russian 309, 310, 321, 322, 323, 324, 405, 410, 412, 414. The courses chosen must be in at least two departments.

Minor for the Doctor of Philosophy Degree. A doctoral candidate who elects Russian Language and Area Studies as a minor must demonstrate a reading command of Russian as tested by examination or by completion of Russian 401 with a grade of A or B, and in addition must earn at least four units of graduate credit in courses chosen from the list given just above. The four units must be distributed among at least two departments.

The adviser for these graduate minors is Professor Ralph T. Fisher, Jr., Director, Center for Russian Language and Area Studies, 331 Lincoln Hall.

SOCIAL SCIENCES

Master of Arts in the Social Sciences. A special program leading to the degree of Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including anthropology, economics, geography, history, philosophy, political science, psychology, social work, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 3.75.

The degree of Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work which are mandatory for the major. At the completion of his studies the student must pass an oral comprehensive examination given by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor C. F. Snider, 324 Lincoln Hall. The general adviser for this degree is Professor C. B. Hagan, 318 Lincoln Hall.

Master of Arts in the Teaching of Social Studies. Candidates for the degree of Master of Arts in the Teaching of Social Studies must earn four units in social studies, three units in education, and one unit in electives. Requirements are (1) social studies selected from not more than three of the following: economics, geography, history, at least two units; philosophy, political science, sociology, four units; (2) two of the following courses: Education 301, 302, 303, 304, one unit; Education 311 and 312, one unit; and Education 456, one unit. The courses in social studies and the electives must be selected with the approval of the adviser. The electives may be in the social studies, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is the same as that required by the division.

The adviser for candidates for this degree is Professor C. E. Nowell, 309 Lincoln Hall.

SOCIAL WORK

The School of Social Work offers two years of graduate professional study leading to the degree of Master of Social Work. Although the basic curriculum of the school is the same for all students, there are opportunities for specialization in case work and group work. Students specializing in group work have their classes on the campus of the Professional Colleges in Chicago and field placements in group work agencies in the city. Those specializing in case work may have classes on either the Urbana or Chicago campus, with field placements in selected agencies nearby.

The school has established an admissions committee which is responsible for reviewing all applications. The committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and pre-professional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. Although no specific undergraduate grade-point average is specified, the applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Preference is given to applicants between the ages of twenty-one and thirty-five, but consideration is given to older applicants who have demonstrated their capacity for social work practice. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthy relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

Because of the limited number of field work placements in acceptable social agencies, the school is compelled to limit its enrollment to the number of field work placements available.

Application must be made to the School of Social Work. The special bulletin issued by the school may be obtained by writing to the Director, School of Social Work, 1204 West Oregon Street, Urbana, Illinois.

GRADUATE TEACHING FACULTY

Professors: Marietta Stevenson (Director of the School of Social Work), Jennette R. Gruener, Florence L. Poole, W. P. Simon.

Associate Professors: Margaret G. Holden, D. E. Lathrope, J. E. McDonald, F. P. Purcell, D. Katharine Rogers, W. Schwartz, D. E. Tanenbaum, L. Jane Wille.
Assistant Professor: Mary E. Reese.
Instructor: Dorothy Rosenstein.

COURSES FOR GRADUATES

421. **Social Work Methods, I.** Principles and practice of social work, integrating classroom and field instruction. Sections A1 and A2 are required of all students; Sections B1 and B2 of casework majors; Sections C1 and C2 of group work majors. I; 2 to 4 units.

Section A1. Community Organization. Emphasis is on the community organization component of social work practice in various settings. Beginning knowledge and illustrative elements of the practice of community organization at the neighborhood, community, county, metropolitan region, state, national, and international levels.

Section A2. Research. Objectives and methods of social work research. Basic principles of designing studies, evaluation of methods of collecting data, construction of schedules, analysis and presentation of results. Prerequisite: A course in elementary statistical method. In lieu of this, a noncredit course in statistical method may be taken concurrently.

Section B1. Social Casework. Consideration of the principles of social work in the practice of social casework. Through discussion of case material from various settings and from his own field experiences, the student is helped to understand social casework method and to use this in helping the client.

Section C1. Social Group Work. Consideration of the principles of social work in the practice of social group work. Dynamics of the group process and the meaning of program activities. The student is helped to use this understanding to enable the individual and the group to develop a capacity for creative relationships.

Sections B2 and C2. Field Instruction. The student is assigned to a social agency in which, under the supervision of a qualified field instructor, he has responsibility for carrying selected cases or for direct work with groups. Instruction is based on the student's own practice and is designed to help him develop skill in social work methods.

422. **Social Work Methods, II.** Continuation of Social Work 421. More extensive analysis and application of the principles of casework and group work. Sections A1 and A2 are required of all students; Sections B1 and B2 of casework majors; Sections C1 and C2 of group work majors. II; 2 to 4 units. Prerequisite: Social Work 421.

Section A1. Generic Principles: Casework and Group Work. Study of principles underlying similarities and differences in giving and taking help within casework and group work relationships. For the student who is concentrating on casework practice, the focus is on working with group situations inherent in casework settings. For the group worker, the focus is on concepts concerning professional help in individual relationships and on the responsible part the group worker can assume within these relationships.

Section A2. Research. Continuation of Social Work 421, Section A2. Critical analysis of research studies in human growth and development, social work methods, and social welfare services.

Section B1. Social Casework. Continuation of Social Work 421, Section B1. Designed to help the student increase his knowledge and improve his skill in the practice of social casework.

Section C1. Social Group Work. Continuation of Social Work 421, Section C1. Designed to help the student increase his knowledge and improve his skill in the practice of social group work.

Sections B2 and C2. Field Instruction. Continuation of the first semester of field instruction.

423. **Social Work Methods, III.** Emphasis is on the student's understanding and skill in social work with broader consideration of practice in various settings. Section A1 is required of all students; Sections B1 and B2 of casework majors; Sections C1 and C2 of group work majors. I; 2 to 4 units. Prerequisite: Social Work 422.

Section A1. Social Work Practice. Social work method in different settings. Ways of determining the nature and content of social work services in various settings; methods of developing effective working relationships in multi-discipline settings. Consideration of content specific to various kinds of agencies in which social work is practiced.

Section B1. Social Casework. Continuation of Social Work 422, Section B1, in a sequential manner, with increased emphasis on the generic, diagnostic, and differential treatment aspects of social casework. Application of the case study method to a variety of settings in which social casework is practiced.

Section C1. Social Group Work. Use of the social group work method with particular attention to the social group work process as related to variations in type, size, and purpose of the group. Advanced material in using program content with the group, and the role of the group worker in planning intra-agency service.

Sections B2 and C2. Field Instruction. Based on the student's own practice in a setting related to his field of specialization. Emphasis is on enhancing the student's skill in practice.

424. **Social Work Methods, IV.** Continuation of Social Work 423. Section A1 is required of all students; Sections B1 and B2 of casework majors; Sections C1 and C2 of group work majors. II; 2 to 4 units. Prerequisite: Social Work 423.

Section A1. Social Work Practice. Social work practice in areas of supervision, consultation, and administration. Emphasis for the casework student is on the understanding of the worker's role in consultation, policy-making, program planning, and interpretation. Emphasis for the group work student is on supervisory and administrative practice with special reference to supervision of volunteer leaders.

Section B1. Social Casework. Continuation of Social Work 423, Section B1. Learning experiences arranged to assist the student to a greater integration of the philosophy, concepts, and principles in social casework.

Section C1. Social Group Work. Continuation of Social Work 423, Section C1. Further discussion of principles and practice in social group work with emphasis on the student's ability to present, analyze, and evaluate material from his own practice.

Sections B2 and C2. Field Instruction. Continuation of the third semester of field instruction.

451. **Dynamics of Human Development, I.** Designed to provide the student with an understanding of normal physical, emotional, and social growth throughout the life cycle. Relevant material is included from the fields of medicine, psychology, psychiatry, and cultural anthropology. I; 1 to 2 units.

453. **Dynamics of Human Development, II.** Understanding of deviations from

normal physiological functioning as demonstrated in major chronic disease processes. Interrelationship of physical, emotional, and social aspects of causation of disease and implications for the patient, family, and community. Discussion of the role of the social worker in collaboration with other disciplines concerned with provision of medical and rehabilitative services. I; 1 to 2 units. Prerequisite: Social Work 451.

454. **Dynamics of Human Development, III.** Concepts and theories used in social work to understand the nature and causes of emotional pathology in social functioning. II; 1 to 2 units. Prerequisite: Social Work 451.

461. **Special Studies in Social Work, I.** Independent or group study in areas of special interest; application of social work principles to special problems or settings. I, II; 1 to 2 units.

462. **Special Studies in Social Work, II.** Independent or group study in areas of special interest; application of social work principles to special problems or settings. I, II; 1 to 2 units.

481. **Social Welfare Organization, I.** Analysis of social welfare as part of the social structure, followed by a historical study of its development, aimed at accounting for the present position of social work and social welfare in American culture. The emergence of specialized services, the contribution of private philanthropy, the expansion of public responsibility, the interrelations of social welfare with other aspects of the culture and historical developments. I; 1 to 2 units.

482. **Social Welfare Organization, II.** Principles and content of public and private programs directly affecting family welfare, particularly income maintenance and related services. Consideration of the social insurances, public assistance, employment services, labor standards, protective legislation, and community-sponsored family service programs. Focus on basic premises, content, objectives, and adequacy of each program as a means of providing protection against economic want, and the maintenance and restoration of the social functioning of individuals and families. II; 1 to 2 units. Prerequisite: Social Work 481.

483. **Social Welfare Organization, III.** Examination of proposals to strengthen programs and services in each of the national, state, and community social welfare programs in the light of evolving needs and changing resources. Consideration of public health, medical care, health insurance, chronic illness and disability, rehabilitation services, mental health care, services for children, urban renewal, programs for the aging, correctional services, and informal education and leisure-time programs. I; 1 to 2 units. Prerequisite: Social Work 482.

484. **Social Welfare Organization, IV.** Analysis of organizational patterns and of the administrative process. Study of the structures of international, national, state, and local public and private agencies to reveal their functions and interrelationships. Review of the administrative process through examination of policy formulation, the executive function, organization, coordination, field services, personnel, budgeting, and public relations. Social action and the legislative process, and current developments and issues in the area of social work are examined. II; 1 to 2 units. Prerequisite: Social Work 483.

491. **Research.** Seminar for students preparing research projects, either in groups or individually. Experience in the application of research methods to current social work problems. I, II; 0 to 2 units. Prerequisite: Social Work 421 and 422, Section A2.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Introduction to Social Casework.** Behavior and attitudes expressed by persons asking for assistance, the feelings thus engendered, and the effects of these upon the contacts of social caseworkers with individuals and families. Attention is given to case records selected from social casework practice in public assistance and other community agencies. I, II; ½ unit.

316. **Social Services for Children.** Unmet needs of children and the organization of social services to meet those needs. Responsibilities of voluntary as well as public agencies are considered. A survey is made of agencies providing leadership and standard setting in social services for children. I, II; ½ to 1 unit. Prerequisite: Junior standing; a major in any of the social sciences, education, recreation, speech correction, or consent of instructor.

333. **Introduction to Social Group Work.** Background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustrations from the field of practice in informal education, recreation, and social group work. I, II; ½ unit.

SOCIOLOGY

The Department of Sociology offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy in Sociology.

The basic program of graduate study for all students taking sociology as a major subject consists of a collection of courses designed primarily to give a broad training in the principles and in the fundamentals of theory, scientific methodology, and research techniques in the general field of sociology. All students must take courses in these areas selected in consultation with the adviser. In addition to the basic program, the department offers opportunities for students to specialize in any one of the several fields within the discipline, including rural sociology. Specialized training to meet the particular needs of each student may be arranged through the selection of appropriate courses in this and other departments in consultation with the adviser, through supervised individual work on special topics, and through the research performed in connection with the preparation of the dissertation.

In order to be considered for admission, students intending to elect sociology as their major must offer:

(1) A grade-point average of at least 3.5;

(2) A minimum of nine semester hours of undergraduate work in sociology;

(3) A course in quantitative research methods in sociology (Sociology 385 or equivalent);

(4) Fifteen semester hours in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Students who can not meet the prerequisites listed in (2), (3), and (4) above may be permitted to register for graduate courses but will be required to remove any deficiencies during the first year of residence by taking without credit such courses as may be prescribed by the adviser. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

The prerequisite for a graduate minor in sociology is six hours of undergraduate work in sociology. Students intending to offer sociology as a minor must consult with the head of the department before registering for courses.

Degree of Master of Arts. The requirements for the degree of Master of

Arts in Sociology are as follows: (1) Completion of a program of eight units of work approved by the adviser, including Sociology 400, a course in research methods, and no more than one unit of thesis credit; (2) Passing the Master's Comprehensive Examination. This examination is given once each semester and summer session on dates announced in advance by the department. The examination consists of a written examination of two three-hour periods, covering the following topics: general theory, quantitative and non-quantitative methods of research, and fields and trends in sociology. (3) Preparation of an acceptable thesis which embodies the results of an original research project. The plan for the thesis must be approved before work is started, by the student's advisory committee consisting of the adviser and two other faculty members appointed by the head of the department. (4) Passing an oral examination, primarily on the thesis, conducted by the student's advisory committee.

Degree of Doctor of Philosophy. The applicant who has obtained his Master of Arts degree from the University of Illinois is judged as to his qualifications for further advanced work on the basis of his academic record and his performance on the Master's Comprehensive Examination. The student must attain a performance rated as a high pass on this examination in order to be permitted to proceed. The applicant whose previous graduate work was done elsewhere may be admitted on a provisional basis and during his first semester of residence must take the Master's Comprehensive Examination. The results of this examination serve to determine his eligibility to continue in the doctoral program and to ascertain the amount of credit toward the doctoral requirements to be allowed for work completed elsewhere.

The student's program of study for the doctorate is selected in consultation with the adviser and must include adequate work in sociological theory and scientific method in sociology, and training in research techniques. The program should be arranged partly with a view toward gaining preparation for the preliminary examination. However, formal course work alone does not provide adequate preparation for the examination. It must be supplemented by an intensive program of individual study and reading selected under the guidance of the adviser.

Upon the recommendation of his adviser, and after he has complied with the regulations of the Graduate College, the student may apply in writing to the head of the department for admission to the preliminary examination, which is given at irregular intervals determined by the needs of the department. This examination consists of a written examination and a two-hour oral examination and is designed to test the candidate's knowledge of his minor fields and his proficiency in the history, theory, methods of research, and substantive content of general sociology, and his knowledge and understanding of the principal special fields of sociology. Information regarding the nature and content of the examination may be obtained from the adviser.

In accordance with the regulations of the Graduate College, at the time of the oral portion of the preliminary examination the student must be prepared to announce the tentative topic of his proposed doctoral dissertation and his general plans for doing the research. He will be examined on his plans, resources, and capability for doing the work proposed for the dissertation. In preparation for this part of the preliminary examination, the student should have consulted with his adviser on this matter from time to time for guidance in his training in research methods and in the formulation of his dissertation proposal.

GRADUATE TEACHING FACULTY

Professors: L. Schneider (Head of Department), J. E. Hulett, Jr., D. E. Lindstrom.

Associate Professors: E. A. Ahrens, Margaret K. Chandler, C. L. Folse, D. Glaser, J. R. Gusfield, R. W. Janes, B. Karsh.
Assistant Professors: B. M. Berger, B. Farber, B. S. Phillips.
Lecturer: N. W. Painter.

COURSES FOR GRADUATES

400. **General Sociology.** Systematic sociology, with emphasis on the development and problems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. I; 1 unit.

407. **Population Studies and Demographic Analysis.** Same as Rural Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections, relationship of economic, sociological, and psychological factors to population changes. I; 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology. Folse.

412. **Seminar on Social and Cultural Relations of Personality.** Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. I, II; 1 unit. Hulett.

414. **Seminar on Social Interaction.** An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. I or II; 1 unit. Prerequisite: One unit of graduate credit in sociology. Hulett.

418. **Seminar on Industrial Sociology.** Same as Labor and Industrial Relations 418. Individual research in sociological interpretation of industrial organization; the orientation and motivation of the individual in industry and commerce; labor-management relations as group adjustments; the interrelations of industry and the community. I or II; 1 unit. Prerequisite: Six hours of sociology including Sociology 318, or consent of instructor. Chandler, Karsh.

421. **Seminar on Research in Marriage and Family Life.** Analysis of relationships between research methodology and conceptual schemes employed to study family life; critical examination of typical studies which illustrate alternatives in the conceptualization of family interaction and the nature of the family unit. I, II; 1 unit. Prerequisite: Consent of instructor. Farber.

422. **Theory of Social Groups.** A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations relevant to the solution of empirical problems in group analysis. I or II; 1 unit.

424. **Seminar in Penology.** Sociological analysis of law enforcement, adjudication, and the rehabilitation of criminals, with emphasis on direct contact with agencies having these functions, and the design of research projects relevant to their problems. I or II; 1 unit. Prerequisite: Sociology 331 or equivalent. Glaser.

425. **Racial and Cultural Minorities.** A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. I or II; 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology. GLASER.

431. **Seminar in Criminology.** Analysis of selected research problems on the development of criminological thought and the investigation of the causes of crime. I or II; 1 unit. Prerequisite: Sociology 331 or equivalent. GLASER.

432. **Critique of Research in Juvenile Delinquency.** Analysis of major investigations into the causes, treatment, and prevention of delinquency and criminality in youth. I or II; 1 unit. Prerequisite: Sociology 331 or consent of instructor; Sociology 431 is recommended. GLASER.

435. **Field Instruction and Research in Penal Sociology.** Problems of designing and conducting criminological research in penal institutions; supervised training and practice in the functions of sociologists in prisons. Conducted only in the summer with the first and eighth weeks spent on campus; six weeks are spent in the offices of sociologists in prisons. Application for admission to this course must be made in April prior to the summer session in which enrollment is desired. S; 1 unit. Prerequisite: Sociology 324 and 331 or equivalent; consent of instructor; passing routine employment clearance procedures (including fingerprinting) required by the prison. GLASER.

444. **Seminar in Public Opinion.** Same as Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. I, II; 1 unit.

446. **Opinion Polling Analysis.** Same as Communications 446. The study of current polling practices, organizations, and findings. Evaluation of results in terms of the prediction and interpretation of social behavior. I, II; 1 unit.

471. **Regionalism and Social Morphology.** Specific analysis of the problems which apply to regional bases and not to the conventional political boundaries. I or II; 1 unit.

473. **The Community in Modern American Society.** Comparative analysis of community life as it is influenced by institutional trends of the larger society. I or II; 1 unit. Prerequisite: Sociology 400. JANES.

476. **Urban Communities and Urbanization.** Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. I or II; 1 unit.

477. **Rural Communities.** Same as Rural Sociology 477. A study of rural community structure, functions, and processes, to give the student a concrete picture of how rural communities operate, and the forces which cause change in the group life of the people living in a rural community. Field trip; estimated expense, $5.00. I or II; 1 unit. LINDSTROM.

480. **Sociological Theory and Method.** This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. I or II; 1 unit.

481. **Seminar in Culture Integration.** I or II; 1 unit.

482. **Recent Developments in Sociology.** Intensive study of selected topics based on contemporary works of major importance in the development of sociological theory. II; 1 unit. Students may reregister for a total of two units credit.

484. **The Practical Applications of Sociology.** Examination of uses of sociology by administrative policy-makers and community leaders, e.g., increasing

industrial and agricultural productivity, reducing social conflict and group tensions; different types of applied sociology, clinical and engineering sociology; theoretical and scientific problems arising in efforts to apply sociology to practical problems and their possible solutions. I, II; 1 unit. Prerequisite: Sociology 400 or consent of instructor.

485. **Advanced Quantitative Methods in Sociology.** Fundamental principles of dealing with multiple variables in sociological research, including such methods as Guttman scale analysis, factor analysis, analysis of variance, and multiple correlation. The range of possible applications for the different stages of sociological research are explored, with illustrations taken from the literature. I or II; 1 unit. Prerequisite: Sociology 385 or equivalent, or consent of instructor. PHILLIPS.

486. **Seminar on Experimental Sociology.** The logic of experimental inquiry compared to other methods of investigation; projected experimental design, ex post facto design, statistical analysis. I or II; 1 unit. Prerequisite: Sociology 385 or equivalent, or consent of instructor. PHILLIPS.

487. **Special Problems in Rural Sociology.** Same as Rural Sociology 487. I, II; ½ to 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

488. **European Sociological Theory.** Selected problems of contemporary sociological thought, e.g., the question of objectivity (sociology of knowledge); what constitutes sociology as a special science; the problem of social dynamics. I or II; 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152.

490. **Individual Topics in Sociology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. I, II; ½ to 2 units. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Sociology of Education.** Same as Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. I, II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152.

317. **Structure and Function of Rural Society in America.** Same as Rural Sociology 317. A functional analysis of the group, institutional, and class structure of contemporary American rural society, with emphasis on regional and subregional variations and the interdependence of the rural and other segments of the total American society. I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Three hours of sociology, eight hours of social science, or consent of instructor. FOLSE.

318. **Industry and Society.** Same as Labor and Industrial Relations 318. Sociology of industry and problems of personal adjustment; the emergence of modern industrial and labor organizations and their impact upon community life. I, II; ½ or 1 unit. Registration for a full graduate unit requires both the approval of the instructor and substantial additional work. Prerequisite: Psychology 100; Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or consent of instructor. KARSH.

320. **Social Roles.** Contemporary role theory and related concepts such as social status and social interaction; age-sex, vocational, social class, and other role

types; applications of this theory to the study of the socialization process and personal adjustment, and the analysis of critical group situations and social change. I or II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. HULETT.

323. **The Small Social Group.** Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. I, II; ½ or 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

324. **Penology.** Probation; parole; methods of institutional treatment. I or II; ½ or 1 unit. Prerequisite: Sociology 331.

328. **Sociology of Leisure.** Social-cultural norms, values, institutionalized behavior patterns, and group relations associated with man's use of leisure time, from the contemporary, comparative, and historical points of view; interrelations of leisure patterns with other aspects of social life such as work, technology, sociability, morality, art, and other institutions. Graduate students registering for a full unit must prepare a substantial research paper in addition to regular class assignments. I, II; ½ or 1 unit. Prerequisite: Three hours of sociology or consent of instructor. BERGER.

331. **Criminology.** Nature and extent of crime; past and present theories of crime causation; criminal behavior in American society and its relation to personal and cultural conditions. I, II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. GLASER.

332. **Prevention and Treatment of Juvenile Delinquency.** Conceptions of delinquency and its causation; the juvenile court movement; juvenile detention; treatment of juvenile offenders; delinquency prevention programs. I or II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or Sociology 331. GLASER.

340. **Social Movements.** Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanisms. I, II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105.

344. **Public Opinion.** Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. I, II; ½ unit. Prerequisite: Sociology 100, or 104 or 105, or Division of General Studies 151 and 152.

372. **Contemporary International Migration.** Demographic, cultural, ideological, and other factors in present-day movements of peoples; controlled and compulsory migration; immigrant groups and displaced persons in the United States; national and international migration policies. I or II; ½ unit. Prerequisite: Three hours of sociology or eight hours of social science.

373. **Latin-American Social Organization and Institutions.** Analysis of contemporary institutional and social class structures in Latin-American communities and societies, and their relationship to certain religious and family patterns; the influence of past and present trends in urbanization, ecological organization, and population growth upon Latin American social systems and institutional organization. I, II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or consent of instructor. PAINTER.

375. **Sociology of the Community.** Nature, structure, and functions of the community; types of communities and examples of some better community studies; the relation of the community to the larger social organization. I

or II; ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or eleven hours of sociology.

378. **Acculturation in Modern Society.** Acculturation as a universal social process. Deals with the influence of contacts between cultures as a factor in social-cultural change. Emphasis is placed on changes in ideology, technology, and personality types as a consequence of contacts between Western, Oriental, and other civilizations. I, II; ½ or 1 unit. Prerequisite: Five hours of sociology. JANES.

385. **Methods of Sociological Research.** The application of principles of research and sampling design to sociological problems; procedures for collection and analysis of data, including the fundamentals of quantitative methods; discussion and criticism of examples of current sociological research. I, II; ½ or 1 unit. Prerequisite: Eight hours of sociology. CHANDLER.

386. **Methods of Field Research.** Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. I, II; ½ or 1 unit. Prerequisite: Three hours in advanced courses in sociology or consent of instructor. KARSH.

SPANISH AND ITALIAN

(Including Portuguese)

The Department of Spanish and Italian offers courses leading to the degrees of Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are Spanish linguistics, Spanish literature, Latin-American literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 3.75. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, or consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for any advanced degree in Spanish must possess or acquire a practical command of the language. For the degree of Doctor of Philosophy, some knowledge of Latin and Italian or Portuguese is required. The Latin requirement may be met by taking a minimum of one semester of Latin while in residence for the degree. Parallel training in one or more other languages or literatures, such as English, French, German, Greek, Italian, Latin, and Portuguese, is desirable.

Degree of Master of Arts.

(1) *Spanish or Latin-American Literature.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 301, 302, 303, 304, 311, 314, 331, 351, 352; (b) Spanish 405 and Spanish 415 or 417; two of Spanish 421, 422, 423, 424; one of Spanish 431, 432, 433, 434. The course program may be supplemented by courses from the Ph.D. list, or by courses totaling one unit in a minor or one unit in each of two minors.

(2) *Spanish Linguistics.* Minimum requirements are: (a) linguistics courses: Spanish 351, 352, 451, and 453; (b) literature, three and one-half units from Spanish 301, 302, 303, 304, 311, and 314, plus electives from the 400-level group; and (c) general linguistics: one and one-half units from Humanities 300, 301, 302, 370, 387.

Degree of Master of Arts in the Teaching of Spanish.

(1) Any of the following not included in an undergraduate program: Spanish 301 and 302, or Spanish 303 and 304 (or both sequences), Spanish 311, 314, 331, 351, 352, Humanities 300; at least three units selected from: Spanish 415 or 417; Spanish 421, 422, 423, or 424; Spanish 431, 432, 433, or 434.

(2) Education, two units: Education 311 and 312, and two of the following: Education 301, 302, 303, and 304.

The adviser for candidates for this degree is Professor Joseph S. Flores, 214 Lincoln Hall.

Degree of Doctor of Philosophy.

(1) *With Specialization in the Renaissance and Golden Age.* The minimum requirements, in addition to those for the A.M., are: Spanish 411; Spanish 415 or 417; one of Spanish 421, 422, 423, 424; Spanish 425 or 426; Spanish 453; two seminars.

(2) *With Specialization in the Nineteenth and Twentieth Centuries.* The minimum requirements, in addition to those for the A.M., are: Spanish 411; two of Spanish 421, 422, 423, 424; Spanish 425 or 426; Spanish 453; two seminars.

(3) *With Specialization in Latin-American Literature.* The minimum requirements, in addition to those for the A.M., are: one of Spanish 421, 425, 426; three of Spanish 431, 432, 433, 434; Spanish 453; two seminars; Portuguese 301 and 302, or 491.

(4) *With Specialization in Spanish Linguistics.* The minimum requirements, in addition to those for the A.M., are (a) linguistics: Spanish 452 and 454; one seminar; (b) literature: Spanish 411; one seminar; (c) general linguistics: Communications 426.

Students working toward the Doctor of Philosophy degree are admitted with provisional departmental status until their performance in graduate work is judged acceptable for full departmental status by the department's Graduate Committee.

The department should be consulted on the selection of minors. Minors available within the department are Spanish linguistics, Italian, Portuguese, Spanish and Latin-American literature. Other appropriate minors are other languages and literatures, history, philosophy, anthropology, linguistics, Latin-American studies, and other closely allied subjects.

Candidates for an advanced degree in Italian or Portuguese should consult the department. Provisions are made to fit individual cases. In special cases, Spanish literature and linguistics may be used reversibly as major and one minor.

GRADUATE TEACHING FACULTY

Professors: W. H. Shoemaker (Head of Department), J. H. D. Allen, H. R. Kahane.

Associate Professors: J. O. Crosby, F. P. Ellison, J. S. Flores, L. Leal, Angelina R. Pietrangeli.

Spanish

COURSES FOR GRADUATES

405. Introduction to Critical Method. I, II; ½ unit. Allen.

411. Spanish Literature in the Middle Ages. I; 1 unit. Allen.

412. Spanish Literature in the Middle Ages. II; 1 unit. Allen.

415. Spanish Literature in the Sixteenth Century. I; 1 unit. Allen.

416. Spanish Literature in the Sixteenth Century. II; 1 unit. Allen.

417. Seventeenth-Century Literature. I; 1 unit. Flores.

418. Seminar on the Works of Cervantes. II; 1 unit. Crosby.

421. **Modern Spanish Novel and Essay.** I; 1 unit. SHOEMAKER.

422. **Contemparary Spanish Novel and Essay.** II; 1 unit. SHOEMAKER.

423. **Modern Spanish Drama.** I; 1 unit. SHOEMAKER.

424. **Contemporary Spanish Drama.** II; 1 unit. SHOEMAKER.

425. **Renaissance and Baroque Poetry in Spain.** I, II; 1 unit.

426. **Spanish Poetry of the Ninteenth and Twentieth Centuries.** I, II; 1 unit.

431. **Spanish-American Poetry: Middle America.** I or II; 1 unit. Prerequisite: Spanish 303 and 304, or equivalent. LEAL.

432. **Spanish-American Poetry: South America.** I or II; 1 unit. Prerequisite: Spanish 303 and 304, or equivalent. ELLISON.

433. **Spanish-American Novel: Middle America.** I or II; 1 unit. Prerequisite: Spanish 303 and 304, or equivalent. LEAL.

434. **Spanish-American Novel: South America.** I or II; 1 unit. Prerequisite: Spanish 303 and 304, or equivalent. ELLISON.

435. **Seminar in Spanish-American Poetry.** I or II; 1 unit. Prerequisite: Spanish 431 or 432. ELLISON.

436. **Seminar in Spanish-American Novel.** I or II; 1 unit. Prerequisite: Spanish 433 or 434. LEAL.

443. **Seminar in Galdós.** Research work in novelistic criticism. Prerequisite: Spanish 301 and 302 or Spanish 421 and 422. I; 1 unit. SHOEMAKER.

444. **Seminar in Spanish Realism and Naturalism.** Research work in nineteenth-century literary theory and practice in novel and drama. II; 1 unit. Prerequisite: Spanish 301 and 302 or Spanish 421 and 422.

445. **Seminar in Twentieth-Century Spanish Literature.** I or II; 1 unit. Prerequisite: Spanish 421 or 422 or 423 or 424 or equivalent. SHOEMAKER.

451. **Survey of Current Research in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. I or II; 1 unit. KAHANE.

452. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. I or II; 1 unit. KAHANE.

453. **History of the Spanish Language.** I or II; 1 unit. KAHANE.

454. **Old Spanish.** I or II; 1 unit. KAHANE.

491. **Special Topics in Spanish.** I, II; ½ to 1 unit. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. ALLEN, KAHANE, SHOEMAKER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Survey of Spanish Literature.** I; ½ unit. Prerequisite: Spanish 201 and 202, or equivalent. CROSBY, ELLISON, FLORES.

302. **Survey of Spanish Literature.** II; ½ unit. Prerequisite: Spanish 201 and 202, or equivalent. CROSBY, FLORES.

303. **Survey of Spanish-American Literature.** I; ½ unit. Prerequisite: Spanish 201 and 202, or equivalent. ELLISON, LEAL.

304. **Survey of Spanish-American Literature.** II; ½ unit. Prerequisite: Spanish 201 and 202, or equivalent. ELLISON, LEAL.

311. **Cervantes.** Introduction to the works of Cervantes, with particular emphasis on *Don Quixote*. I, II; ½ unit. Offered in alternate semesters with Spanish 314. Prerequisite: Spanish 201 and 202, or equivalent. CROSBY.

314. **Spanish Drama of the Golden Age.** I, II; ½ unit. Offered in alternate semesters with Spanish 311. Prerequisite: Spanish 201 and 202, or equivalent. FLORES.

331. **La Cultura Hispánica: España.** I; ½ unit. Prerequisite: Spanish 201 and 202. Ellison.

351. **Phonetics.** I, II; ½ unit. Prerequisite: Spanish 201 and 202, or equivalent. Flores.

352. **Syntax.** I, II; ½ unit. Prerequisite: Spanish 201 and 202, or equivalent. Kahane.

371. **Spanish for Teachers.** A consideration of language problems suggested by teaching experience. S; ½ unit. Prerequisite: Spanish 201 and 202, or equivalent. Flores.

Italian

COURSES FOR GRADUATES

411. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** I; 1 unit. Offered in 1961-1962 and in alternate years. Pietrangeli.

412. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** II; 1 unit. Offered in 1961-1962 and in alternate years. Pietrangeli.

415. **Italian Literature of the Renaissance.** I; 1 unit. Offered in 1960-1961 and in alternate years. Pietrangeli.

416. **Italian Literature of the Renaissance.** II; 1 unit. Offered in 1960-1961 and in alternate years. Pietrangeli.

451. **History of the Italian Language.** I; 1 unit. Kahane.

452. **Seminar in Italian Linguistics.** II; 1 unit. Kahane.

491. **Special Topics in Italian.** I, II; ½ to 1 unit. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Kahane.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Dante: La Divina Commedia.** I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. Pietrangeli.

312. **Dante: La Divina Commedia.** Continuation of Italian 311. II; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. Pietrangeli.

321. **Modern Italian Literature.** I; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. Pietrangeli.

322. **Modern Italian Literature.** II; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Italian 101 and 102. Italian 103 and 104 are desirable. Pietrangeli.

Portuguese

COURSES FOR GRADUATES

491. **Special Topics in Portuguese.** I, II; ½ to 1 unit. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Allen, Kahane.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Brazilian Literature.** Survey of the contemporary Brazilian novel. I; ½ unit. Prerequisite: Portuguese 101 and 102. Portuguese 103 and 104 are desirable. Allen.

302. Introduction to Portuguese Literature. Survey of the Golden Age of Portuguese. II; ½ unit. Prerequisite: Portuguese 101 and 102. Portuguese 103 and 104 are desirable. ALLEN.

SPEECH

The Department of Speech offers courses leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy.

The admission requirement, in terms of grade-point average, is at least 3.5.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theater, oral interpretation, speech science, speech and hearing disorders. They may also select a special curriculum in the teaching of speech.

For the degree of Master of Science, students may take a special curriculum in speech correction.

For the degree of Doctor of Philosophy, students may exercise one of three options: rhetoric and public address; the theater; speech science and phonetics, speech and hearing disorders.

In addition to the general regulations of the Graduate College with respect to entrance, distribution of credits, examinations, and theses, the Department of Speech specifies the requirements listed below.

Degree of Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech. If he does not present sixteen hours of credit in speech, he must make up the deficiency before he can be regarded as a candidate for a graduate degree. His record should include these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theater, and an advanced course in public speaking or discussion.

In consultation with the head of the department, the candidate chooses an adviser with whom he should confer about all details of his program.

A normal program of study requires eight graduate units (four each semester) for graduation. The student with a well-rounded undergraduate education may take all eight units in speech; other students are expected to declare a major in speech (to consist of at least four units) and one or two minors in related fields of study outside the department. As a rule, a minor does not exceed two units.

Whether or not a thesis is presented depends upon the candidate's educational and professional aims. After consultation with the student, the student's adviser and the head of the department decide in each case whether a thesis should be submitted as part of the degree requirements. Students who expect to go on to a doctor's degree as a rule are required to present a thesis.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated. The examination covers in part the general field of speech and in part the candidate's area of specialization.

Degree of Master of Arts in the Teaching of Speech. Candidates for the Master of Arts degree who are interested in public school teaching should meet the following requirements:

(1) In the area of rhetoric and public address: Speech 311 and 312, one-half unit each; Speech 322 and 423, one unit each; and education, two units, including two of the following: Education 301, 302, 303, 304, one unit, and Education 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of the theater: speech, four units, including Speech 361 or 362 or 366, 352, 451, 452; education, two units, including two of the following: Education 301, 302, 303, 304, and Education 311 and 312; electives, two units.

Degree of Master of Science in Speech Correction. This program is designed for teachers who desire to obtain an advanced degree in speech correction. The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all of the requirements may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 387, 475, 476, 481, 486, 488, 489, 491, 495; one unit from Education 301, 302, 303, 304, and one unit from Education 311 and 312; two units of electives. The electives may be in speech, in education, in psychology, or, in exceptional cases, in other fields.

Degree of Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree in speech or theater from an accredited institution. In consultation with the head of the department, the doctoral candidate secures a departmental adviser.

GRADUATE TEACHING FACULTY

Professors: K. R. Wallace (Head of Department), E. T. Curry, G. Fairbanks, B. Hewitt, Marie K. Hochmuth, L. S. Hultzén, R. Murphy, Severina E. Nelson, J. J. O'Neill, C. H. Shattuck, J. W. Swanson.

Associate Professors: M. T. Cobin, O. A. Dieter, H. E. Gulley, H. L. Mueller, R. E. Nadeau, J. W. Scott, K. A. Windesheim.

Assistant Professors: Clara M. Behringer, K. Burns, Genevieve Richardson.

Instructor: W. L. Smalley.

COURSES FOR GRADUATES

403. Seminar for Teachers of Speech. Investigations of current principles, materials, and developments in the field of speech and of their relationship to the teacher. I, II; 1 unit. Burns.

411. The Greek Tradition in Rhetoric and Oratory. The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to the Renaissance; analysis of the contributions of major figures and works to that tradition. I; 1 unit. Nadeau.

412. The Roman Tradition in Rhetoric and Oratory. Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. II; 1 unit. Dieter.

423. The Rhetoric of Aristotle. Study of the *Rhetoric* in relation to other works of Aristotle. I; 1 unit. Wallace.

430. Contemporary Theories of Oral Communication. Systematic study of speech-making and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. I or II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Consent of instructor. Gulley.

436. Seminar in Public Discussion. Investigation of special problems in public discussion. II; 1 unit. Offered in 1960-1961 and in alternate years. Murphy.

438. Seminar in Rhetorical Theory. Study of special topics in the history of rhetorical theory. II; 1 unit. Wallace.

441. Principles and Theories of Oral Interpretation. Historical survey of British and American theories of interpretation. I; 1 unit. Cobin.

442. Seminar in Oral Interpretation. Investigation of basic problems in the

history, nature, and function of oral interpretation. II; 1 unit. Prerequisite: Speech 441; consent of instructor. COBIN.

451. **Problems in Play Directing in the School Theater.** Study of the audience, play selection, the actor's abilities and needs, try-outs and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. I; 1 unit. SWANSON.

452. **Problems in Play Production in the School Theater.** Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. II; 1 unit. SWANSON.

461. **Advanced Theater Techniques.** Individual development of advanced techniques of acting and staging through supervised participation in public productions. S; ½ to 1 unit. Prerequisite: At least one semester of graduate study in the area of theater; consent of head of the department and instructor. BEHRINGER.

463. **Seminar in the History of Acting.** Studies in the history and theory of the art of acting. II; 1 unit (students may accumulate 2 units). Offered in 1961-1962 and in alternate years. SHATTUCK.

465. **Seminar in Theater Art.** Studies in the aesthetics of the theater. I; 1 to 2 units. HEWITT.

468. **Seminar in Theater History.** Studies in the history of the theater. II; 1 to 2 units. HEWITT.

472. **Psychoacoustics of Speech.** Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. II; 1 unit. Prerequisite: Consent of instructor. CURRY.

473. **Seminar in Phonetics.** Same as Communications 442 and Humanities 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. I or II; 1 unit. Prerequisite: Consent of instructor. HULTZÉN.

475. **Experimental Phonetics, I.** Same as Communications 475 and Humanities 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. I; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

476. **Experimental Phonetics, II.** Same as Communications 476 and Humanities 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. II; 1 unit. Prerequisite: Consent of instructor. FAIRBANKS.

477. **Measurement of Speech, I.** Same as Humanities 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. I; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. FAIRBANKS.

478. **Measurement of Speech, II.** Same as Humanities 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. II; 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. FAIRBANKS.

479. **Seminar in Experimental Phonetics.** Same as Communications 479 and Humanities 479. Advanced consideration of experimental research in the physiological, acoustical, and psychophysical aspects of speech and hearing. Extensive survey of current literature. S; 1 unit. Prerequisite: Speech 475 and 476, or consent of instructor. FAIRBANKS.

483. **Psychology of Speech and Hearing Disorders, I.** A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. II; 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. **Psychology of Speech and Hearing Disorders, II.** A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. I; 1 unit. Prerequisite: Consent of instructor. O'NEILL.

486. **Advanced Clinical Techniques in Speech and Hearing.** Practice of advanced clinical therapy for speech and hearing disorders; semi-independent management of complex difficult cases; participation in examination and analysis. I, II; ½ to 4 units. Prerequisite: Consent of instructor. CURRY, NELSON.

488. **Diagnosis of Speech Disorders.** Study of diagnostic procedures used in analysis of symptoms involved in speech disorders. II; 1 unit. NELSON.

489. **Seminar in Organic Speech Disorders.** Principles and methods of clinical and classroom correction of speech disorders associated with organic dysfunctions. I or II; 1 unit. Prerequisite: Consent of instructor. NELSON.

491. **Seminar in Hearing Disorders.** Principles and methods of clinical and classroom management of all types of hearing disorders. Survey of current literature and research. I or II; 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Speech 391.

495. **Special Problems.** Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. I, II; 1 to 2 units. Prerequisite: Consent of the head of the department. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. COBIN, CURRY, DIETER, FAIRBANKS, GULLEY, HEWITT, HOCHMUTH, HULTZÉN, MURPHY, NADEAU, NELSON, O'NEILL, SHATTUCK, SWANSON, WALLACE, WINDESHEIM.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Phonetics.** Same as Humanities 301. Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. I, II; ½ to 1 unit. HULTZÉN, MUELLER.

311. **British Public Address.** Study of representative British speakers from the sixteenth century to the present. Lectures, reports, and papers. I; ½ to 1 unit. MURPHY.

312. **American Public Address.** Study of representative American speeches from the sixteenth century to the present. II; ½ to 1 unit. HOCHMUTH.

322. **Modern Rhetorical Theory.** Significant movements in the development of rhetorical theory in England, France, and America from 1700 to 1950. I or II; ½ to 1 unit. HOCHMUTH.

342. **Advanced Oral Interpretation.** Oral interpretation of poetry. I, II; ½ to 1 unit. Prerequisite: Speech 141. COBIN, NELSON.

345. **Contemporary Approaches to Oral Interpretation.** Concepts underlying the contemporary practice of oral interpretation. I, II; ½ to 1 unit. Prerequisite: Speech 141 or consent of instructor. COBIN.

352. **Theories of Play Production.** Origin and development of modern theatrical production; a critical examination of contemporary ideas and practices in theater architecture, acting, directing, and staging. I; ½ to 1 unit. HEWITT.

353. **Creative Dramatics for Children.** A study of the subject matter and techniques of creative dramatics for children, with laboratory application. S; ½ to 1 unit. Prerequisite: Consent of instructor.

354. **Theater for the Child Audience.** A study of the history, the objectives, and the techniques of play production for the child audience, with laboratory application. S; ½ to 1 unit. Prerequisite: Consent of instructor.

355. **Advanced Play Directing.** A study of advanced directing techniques; styles of drama; specialized procedures. I or II; ½ to 1 unit. Prerequisite: Speech 255 or equivalent. BEHRINGER, SWANSON.

361. **History of the European Theater to the Renaissance.** The theater and the theater arts of ancient and of medieval Europe. I; ½ to 1 unit. SCOTT.

362. **History of the European Theater from the Renaissance to 1900.** The European theater and the theater arts from 1576 to 1900, with special reference to the English theater. II; ½ to 1 unit. SCOTT.

363. **Advanced Playwriting.** Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing the full-length play. I, II; ½ to 1 unit (students may accumulate 2 units). Prerequisite: Speech 263; consent of instructor. SMALLEY.

366. **Development of the American Theater.** The development of the theater and theater arts in America from colonial times to the beginning of the twentieth century. I or II; ½ to 1 unit. HEWITT.

368. **History of Theater Costume.** A survey of the history of costumes worn on the stage from the classical Greek period to the present. II; ½ to 1 unit. RICHARDSON.

370. **Stage Scenery Design.** Theory and practice of designing stage scenery. II; ½ to 1 unit. Prerequisite: Speech 157 and two of the following: Speech 255, 352, 361, 362; or consent of instructor.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as English 371. I; ½ to 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as English 372. II; ½ to 1 unit. HERRICK.

373. **Phonetics and Phonemics.** Same as Communications 373 and Humanities 373. Methodologies of phonetics with special application to English; general principles of phonemic interpretation. I or II; ½ to 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Speech 301. HULTZÉN.

375. **Speech Science.** Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. I, II; ½ unit. Prerequisite: Consent of instructor. FAIRBANKS.

376. **Speech Science.** Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. II; ½ unit. Prerequisite: Speech 375 or consent of instructor. FAIRBANKS.

385. **Speech Correction.** Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; obser-

vation and practice in clinical techniques are provided in the laboratory. I; ½ unit. Prerequisite: Ten hours of speech or consent of instructor. O'Neill.

386. **Practicum in Speech Diagnosis and Therapy.** Observation, practice, and research in diagnosis and therapy of speech disorders. I, II; ½ unit. Prerequisite: Speech 385. O'Neill.

387. **Voice and Articulation Disorders.** Principles and methods of clinical and classroom correction of voice and articulation disorders. I or II; ½ to 1 unit. Prerequisite: Speech 385; consent of instructor.

388. **Speech Correction.** Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and glandular disorders. II; ½ to 1 unit. Prerequisite: Speech 385. Staff.

391. **Introduction to Hearing Disorders.** Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. I or II; ½ to 1 unit. Prerequisite: Speech 301 and 375, or consent of instructor. Curry.

393. **Aural Rehabilitation.** Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling; clinical and classroom practice with children and adults. I, II; ½ to 1 unit. Prerequisite: Speech 391; consent of instructor. Required in the curriculum of teacher training in speech correction.

395. **Audiometry and the Use of Hearing Aids.** Selective and diagnostic tests of hearing, the planning and conduct of hearing conservation programs, general problems involved in the use of hearing aids. I, II; ½ to 1 unit. Prerequisite: Speech 376. Curry.

396. **Differential Diagnosis of Hearing Disorders in Young Children.** Special tests and procedures for the measurement of residual hearing in young children; the effects of complex peripheral and central auditory dysfunctions on communication training; the use of non-wearable amplifiers with young children; practice in clinical techniques. II; ½ to 1 unit. Prerequisite: Speech 391 and 395, or consent of instructor.

397. **Measurement of Auditory Perception.** Principles and methods of clinical assessment of auditory perception. Intensive study of measurement techniques for speech perception; applications with clinical clients; survey of current literature and research. I; ½ to 1 unit. Prerequisite: Speech 391. Curry.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

Graduate students electing theoretical and applied mechanics as their major must have had the equivalent of the undergraduate courses in mechanics required for a bachelor's degree in any of the curricula in the College of Engineering. Admission to graduate study in this department requires a 3.5 grade-point average.

Candidates for the Doctor of Philosophy degree are required to take, in addition to the thesis, at least one-half unit from each of the following areas in the department: (1) advanced analytical methods in mechanics, (2) dynamics or vibrations, (3) fluid mechanics, (4) mechanics of solids. A student majoring in one of these four areas in mechanics may also select another of these areas as a second minor, provided that he also takes a first minor in a field other than mechanics.

The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science degree is one unit; for the Doctor of Philosophy degree, the requirement for a sole minor is four units and for a second minor, two units.

In the program for graduate study, emphasis is placed on both course work and research, the latter being either analytical or experimental. The department, as part of the Engineering Experiment Station, conducts many research investigations and makes studies of importance to the engineering, manufacturing, and other industrial interests as well as to various governmental agencies. Some of the areas of greatest research activity are properties of materials and the elastic and inelastic behavior of load-resisting members; fracture of metals, including stress corrosion cracking, fracture under sustained loading, low temperature embrittlement, cleavage, stress rupture in creep, etc.; properties and behavior of plain concrete, reinforced concrete beams, columns, footings, slabs, and frames; creep of metals and of plastics and other inelastic behavior of materials; hydraulics and fluid mechanics including the nature of turbulence, boundary layer theory, etc.; stresses in railway car wheels, rails and bolted and welded rail joints; mechanical vibrations of machines and structures and vibration damping; photoelastic, electric strain gage, and other methods of experimental stress analysis; materials subjected to static and dynamic loads; theoretical analyses of problems in fluid flow, dynamics, theory of elasticity, and theory of plasticity. Controlled environment facilities are available for investigations of plastics, plain and reinforced concrete, and wood.

For information concerning applied mathematics, see page 212.

GRADUATE TEACHING FACULTY

Professors: T. J. Dolan (Head of Department), A. P. Boresi, C. E. Bowman, W. L. Collins, H. T. Corten, P. G. Jones, C. E. Kesler, H. L. Langhaar, W. M. Lansford, J. M. Robertson, O. M. Sidebottom, G. M. Sinclair, J. O. Smith, M. C. Stippes, C. E. Taylor, H. R. Wetenkamp.

Associate Professors: M. E. Clark, J. Morrow, W. J. Worley.

Assistant Professors: F. Bauling, A. C. Bianchini, G. A. Costello, R. S. Jensen, R. E. Miller.

COURSES FOR GRADUATES

400. **Seminar in Engineering Mechanics.** There are many special topics in the field of mechanics such as fracture of metals, creep of materials, etc., in mechanics of solids; fluid flow problems such as the nature of turbulence, boundary layer theory, nature and effects of roughness of boundary, effects of free surface; dynamics problems such as vibration of beams with moving loads, the gyroscope, etc. Such special topics as these are covered in this course. Each semester one or more of these topics is selected and announced as the area to be covered in this course during that semester. I, II; ¼ unit. Staff.

412. **Vibration Analysis.** Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's method; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; non-linear systems. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 311. Jones, Stippes.

416. **Energy Principles in Engineering Mechanics.** Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation, and applications of the principle of virtual displacements, the principle of minimum potential energy, the principle of complementary energy, Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion constitute the main part of the course. Variational methods of approximation are treated briefly. The material includes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. I; 1 unit. Prerequisite: Mathematics 343 is desirable. LANGHAAR.

421. **Mechanics of Materials.** Methods of obtaining relations between loads, deformations, stresses and strains in various members. The main topics covered in this course and in Theoretical and Applied Mechanics 422 are curved beams, unsymmetrical bending, thick-walled cylinders, beams on elastic supports, contact stresses, torsion of members with non-circular cross-section, stress concentrations, elastic energy methods applied to statically indeterminate members, flat plates, inelastic behavior of various types of members. Introduction to mathematical theory of elasticity; elastic and plastic buckling; criteria of failure by yielding and by fracture. I; ½ to 1 unit. SIDEBOTTOM, SMITH.

422. **Mechanics of Materials.** Continuation of Theoretical and Applied Mechanics 421. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 421. SIDEBOTTOM, SMITH.

424. **Properties of Engineering Materials.** Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. II; ½ to 1 unit. CORTEN.

427. **Theories of Mechanical Properties and Behavior of Plain Concrete.** Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial are emphasized. The studies involve critical reviews of experimental and analytical investigations. I; ½ to 1 unit. Prerequisite: Bachelor of Science degree in Engineering. KESSLER.

431. **Theory of Ideal Fluid Flow.** Together with the following course, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible viscosity. The differential equations of motion are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. I; 1 unit. Prerequisite: An elementary course in fluid flow and a course in advanced calculus or equivalent. ROBERTSON.

432. **Theory of Flow of Viscous Fluids.** Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially. Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the

stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. II; 1 unit. Prerequisite: An elementary course in fluid flow and a course in differential equations or in advanced calculus. ROBERTSON.

441. **Applied Analysis in Engineering.** A course to provide training in applications of mathematics to engineering problems. Most of the illustrations are taken from engineering mechanics. I; 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. LANGHAAR, MILLER.

442. **Applied Analysis in Engineering.** Continuation of Theoretical and Applied Mechanics 441. II; 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. LANGHAAR, MILLER.

451. **Theory of Elasticity with Application to Engineering Problems.** A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. I, II; 1 unit. BORESI, LANGHAAR.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR.

454. **Theory of Shells.** A course designed to provide the theoretical basis of stress analysis of shell-type structures, such as ships, submarines, monocoque aircraft structures, concrete roofs and domes, pressure vessels, and containers for liquids. The material includes the differential geometry of shell theory, equilibrium equations, momentless theory of shells, strains in shells, statically indeterminate problems of shells, energy formulations, and stability of shells. II; 1 unit. Prerequisite: Mathematics 343 or equivalent; Theoretical and Applied Mechanics 451 is desirable but not required; Mathematics 341 or 345 is desirable. LANGHAAR.

461. **Inelastic Behavior of Engineering Materials (Theory of Plasticity).** An outline of a general theory of inelastic behavior involving the relations between loads and stresses and strains in various members that are stressed beyond the elastic range. The cases considered include those in which the inelastic actions involve bodies which are made of materials that behave ideally viscous, ideally plastic, and combinations of the two. Some specific topics are mechanisms of inelastic action of members in which the stresses and strains are essentially uni-axial, such as straight beams, curved beams, and members subjected to combined axial and bending loads; deflection of beams; statically indeterminate members loaded inelastically; inelastic buckling; "shake down" of simple statically indeterminate members; etc. I; ½ to 1 unit. SMITH.

462. **Inelastic Behavior of Engineering Materials (Theory of Plasticity).** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading function. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational

plasticity. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. LANGHAAR, SMITH.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. II; ½ to 1 unit. Prerequisite: Courses in advanced calculus and differential equations are desirable. COSTELLO, LANGHAAR.

493. **Advanced Independent Study (Special Problems).** Individual investigation of studies, either analytical or experimental, in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. I, II; ½ to 2 units. STAFF.

499. **Thesis Research.** I, II; 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Mechanical Vibrations.** Kinematics of vibratory motion; comprehensive study of motion having single degree of freedom; critical speeds of shafts; vibration of systems with several degrees of freedom. Applications to engineering problems. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 154, 156, or 211 and 221. JONES.

314. **Advanced Dynamics for Engineers.** Three-dimensional kinematics of a rigid body, general dynamics of a rigid body, moments and products of inertia, kinetic energy, rotation of a rigid body about a fixed axis and about a fixed point, Euler equations of motion, gyroscopic theory; introduction to Lagrange equations; engineering applications. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 211 or equivalent; Mathematics 341 or 345. BORESI.

321. **Advanced Mechanics of Materials.** Methods used in elementary mechanics of materials are expanded and generalized and used to solve more complex problems. Thick-walled cylinders, torsion of bar having noncircular cross section; curved beams, unsymmetrical bending, flat plates; theories of failure. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or 224. SIDEBOTTOM, SMITH.

323. **Advanced Laboratory in Materials Testing.** Calibration of testing machines and of strain measuring instruments; use of various mechanical and electrical strain gauges; interpretation of test results; relation of tests to specifications of materials. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. WETENKAMP.

326. **Experimental Stress Analysis.** Measurement of stresses or deformations that are of significance in the engineering design of load-resisting members; use of optical, electrical, and mechanical instrumentation, models, analogies, brittle coatings, electrical resistance gauges, photoelasticity, etc. I, II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 221, and 223 or 224. Theoretical and Applied Mechanics 321 is desirable. BOWMAN.

334. **Fluid Mechanics and Advanced Hydraulics.** A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer,

pumps, turbines. Some laboratory work. II; ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. LANSFORD, MILLER.

346. **Dimensional Analysis and Theory of Models.** The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary-layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. I; ½ to 1 unit. LANGHAAR, WORLEY.

VETERINARY MEDICAL SCIENCE

Candidates for the Master of Science and Doctor of Philosophy degrees in Veterinary Medical Science must have a Bachelor of Science or a Doctor of Veterinary Medicine degree from a college or university approved by the University of Illinois. If they do not have a veterinary degree, their undergraduate training must be approved by the graduate faculty of the department as appropriate to advanced study. They must have a minimum grade-point average of 3.5.

Areas of specialized study in veterinary medical science include anatomy, microbiology, parasitology, pathology, physiology, and pharmacology.

Students who intend to take graduate work for a Master of Science or Doctor of Philosophy degree in Veterinary Medical Science should include in their undergraduate program at least five hours of physics or mathematics, fourteen hours of chemistry, and fifteen hours of biological sciences. A student who is deficient in these subjects may enter the Graduate College but is required to take the prerequisite courses without graduate credit to remove the deficiency during the first year of residence.

Each graduate student, upon initiation of his program, should arrange with his adviser for orientation by an advisory committee consisting of three or more faculty members. The meeting with the committee may be arranged at the beginning of each fall semester; additional meetings may be arranged during the year at the discretion of the student and adviser. No fewer than three of the areas in the Veterinary Medical Science department should be represented on this committee for students who do not possess the D.V.M. degree or its equivalent.

Students planning to work toward the Doctor of Philosophy degree who enter the University of Illinois without previous graduate training are evaluated by the graduate faculty of the department at the end of their first year of residence in order to determine whether their progress is acceptable for work toward the doctorate. This evaluation is based in part upon an examination.

Students planning to work toward the Doctor of Philosophy degree who enter the University of Illinois with previous graduate training must present a transcript of their completed graduate courses to the head of the department preceding approval for further study to determine what transfer credit toward the doctoral requirements will be allowed to work completed elsewhere. Prior to the end of the first year of residence, an evaluation of the student's progress toward the doctoral requirement is made by the graduate faculty of the department. The evaluation is based in part upon an examination.

Departmental requirements for the degree of Master of Science or Doctor of Philosophy in Veterinary Medical Science, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department. This pamphlet also contains more detailed descriptions of the courses in veterinary medical science and suggests appropriate course sequences.

GRADUATE TEACHING FACULTY

Professors: C. A. Brandly (Dean of College of Veterinary Medicine), J. O. Alberts, P. D. Beamer, L. E. Boley, H. J. Hardenbrook, R. D. Hatch, N. D. Levine, R. P. Link, E. F. Reber, M. Ristic, J. Sampson, L. E. St. Clair.
Associate Professors: D. H. Ferris, L. E. Hanson, A. M. Watrach.
Assistant Professor: H. E. Rhoades.
Instructor: A. H. Safanie.

COURSES FOR GRADUATES

408. **Principles of Hematology.** The cellular morphology of the blood and bone marrow of animals in health and disease. Lectures, discussions, demonstrations, and laboratory. II; ½ unit. Prerequisite: Veterinary Medical Science 311 or equivalent, or consent of instructor. St. Clair.

415. **Mechanisms of Microbial Infections.** Concepts of host-microorganisms relations with emphasis given to the dynamics of microorganisms and pathogenesis of specific infections. I; 1 unit. Prerequisite: Microbiology 326 or Veterinary Medical Science 323, or equivalent. Hanson, Ristic.

416. **Epizootiology.** Principles and problems of epizootiology with special consideration of the zoonoses; ecology, perpetuation, and distribution; the principles and factors in interference, carrier, and latent states, reservoirs and control. II; 1 unit. Prerequisite: Bacteriology 300 and Veterinary Medical Science 323 or equivalent; consent of instructor. Brandly, Ferris, Levine.

417. **Medical Mycology.** Study of the fungi that cause infections in man and animals; taxonomy, methodology, epidemiology, pathology, and diagnosis. I; ½ unit. Prerequisite: Microbiology 326 or Veterinary Medical Science 323, or equivalent. Rhoades, Watrach.

430. **Advanced Veterinary Parasitology.** Isolation, identification, cultivation, chemotherapy, and host-parasite relations of protozoan, helminth, arthropod, and fungal parasites of domestic animals. II; ½ to 1 unit. Prerequisite: Veterinary Pathology and Hygiene 324 or Zoology 318 and 321, or equivalent; Chemistry 133 or equivalent. Levine.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy 440, Animal Science 440, Dairy Science 440, and Horticulture 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. I; 1 unit. Prerequisite: Consent of instructor. Jacob.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy 441, Animal Science 441, Dairy Science 441, and Horticulture 441. A continuation of Veterinary Medical Science 440 moving into the more complex designs and methods of analysis. II; 1 unit. Prerequisite: Veterinary Medical Science 440 or equivalent. Jacob.

445. **Advanced Macroscopic Pathology.** Concepts and interpretations of gross pathological changes and the integration of host-parasite reactions. I, II; ½ to 1 unit. Prerequisite: Veterinary Medical Science 325 and 326 or equivalent and consent of instructor. Alberts, Beamer.

450. **Advanced Veterinary Pathology.** Advanced study of gross and microscopic pathology of diseases of domestic animals. Prerequisite: Veterinary Pathology and Hygiene 326 or equivalent. I; 1 unit. Beamer.

460. **Advanced Veterinary Physiology.** Advanced study of physiology, nutrition, and biochemistry as related to problems in veterinary medical science. Prob-

lems studied include white muscle disease, sweet clover disease, ketosis, hypoglycemia, and digestive disturbances. Laboratory includes planning, executing, and reporting a specific course project. I; 1 unit. Prerequisite: Veterinary Medical Science 321, 322, or equivalent; consent of instructor. Reber, Sampson.

461. **Advanced Veterinary Pharmacology.** Evaluation of drugs, pharmacological aspects of biological antagonisms, antimetabolites, chemotherapy, antibiotics, chelating agents, and chemical-biological correlations. II; ¾ unit. Prerequisite: Veterinary Medical Science 330 or consent of instructor. Link.

490. **Seminar.** Required of all graduate students whose major is veterinary medical science. I, II; 0 to ¼ unit. Brandly and staff.

491. **The Experimental Method in Veterinary Research.** Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. I; ½ unit. Levine.

492. **Special Problems.** Basic and applied study including orientation and research on pertinent initial and continuing problems in the student's area of interest. (Not more than one unit of Veterinary Medical Science 492 may be offered toward an M.S. degree or two units toward a Ph.D. degree.) I, II; ¼ to 1 unit. Prerequisite: Consent of instructor. Staff.

499. **Thesis Research.** I, II; 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Gross Anatomy.** Systematic and topographic study and dissection of the dog. I; 1 unit. Prerequisite: Five hours of zoology; consent of instructor. St. Clair.

312. **Gross Anatomy.** Comparative study and dissection of the domestic animals, with special reference to development and adaptation to function. II; 1 unit. Prerequisite: Veterinary Medical Science 311 or consent of instructor. St. Clair.

313. **Histology and Embryology.** Structure and development of cells and tissues with special reference to domestic animals. I; 1 unit. Prerequisite: Five hours of zoology; consent of instructor. Safanie.

314. **Histology and Embryology.** Structure and development of organs and systems with comparison in different domestic animals. II; 1 unit. Prerequisite: Veterinary Medical Science 313 or consent of instructor. Safanie.

321. **Physiology.** Blood and lymph, circulation, respiration, digestion, absorption, and excretion. Lectures, quizzes, demonstrations, and laboratory. I; 1 unit. Prerequisite: Courses totaling twenty semester hours in chemistry or animal biology, or both; consent of instructor. Sampson.

322. **Physiology.** Metabolism, heat production, endocrine organs, muscle and nerve, central nervous system, special senses, and reproduction. Lectures, quizzes, demonstrations, and laboratory. II; 1 unit. Prerequisite: Courses totaling twenty semester hours in chemistry or animal biology, or both; consent of instructor. Sampson.

323. **Bacteriology and Immunology.** Cultural requirements, propagation, isolation, and identification of microbial agents causing disease of domestic and wild animals; serological methods and immunological concepts. Lectures, quizzes, laboratory. I; 1 unit. Prerequisite: Bacteriology 300; consent of instructor. Hanson.

324. **Parasitology.** Protozoa, helminths, arthropods, and other parasites affecting domestic animals. Prerequisite: Courses totaling twenty hours in chemistry or animal biology, or both; consent of instructor. I; 1 unit. Levine.

325. **General Pathology.** The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasms. Lectures, quizzes, demonstrations, and laboratory. II; 1 unit. Prerequisite: Courses totaling twenty-five hours in histology, parasitology, physiology, and microbiology; consent of instructor. WATRACH.

326. **Special Pathology.** Disease processes affecting organs and anatomic systems and those occurring in specific diseases. Lectures, quizzes, demonstrations, and laboratory. I; 1 unit. Prerequisite: Veterinary Medical Science 325 or equivalent; consent of instructor. BEAMER.

327. **Parasitology.** Protozoa, helminths, arthropods, and other parasites affecting domestic animals. I; ½ unit. Prerequisite: Credit or registration in Veterinary Medical Science 324; consent of instructor. LEVINE.

329. **Pharmacology.** General principles of pharmacy and an analysis of the action of chemical agents on physiological processes. Lectures and discussion. II; 1 unit. Prerequisite: Credit or registration in Veterinary Medical Science 321 and 322; consent of instructor. LINK.

330. **Pharmacology.** Principles of drug action and an analysis of the action of chemical agents on living organisms. II; ¾ unit. Prerequisite: Veterinary Medical Science 329 or consent of instructor. LINK.

361. **Histological and Histochemical Methods.** Cellular activities and chemical reactions of tissues; methods and techniques employed in studying microscopic anatomy. Lectures, discussions, demonstrations, and laboratory. I; ½ to 1 unit. Prerequisite: Five hours of zoology. ST. CLAIR.

362. **Preparations in Gross Anatomy.** Methods used in preparing specimens for the museum and for use in studying gross anatomy. II; ½ to 1 unit. Prerequisite: Five hours of zoology. ST. CLAIR.

392. **Special Problems.** Individual research on a special problem chosen after consultation with the instructor and department head. I, II; ½ unit. Prerequisite: Registration in veterinary medical curriculum with grade-point average of 3.5 or above. STAFF.

ZOOLOGY

The Department of Zoology offers work leading to the degrees of Master of Science and Doctor of Philosophy. Students applying for admission must have a 4.0 grade-point average.

The department offers work in five areas of specialization: vertebrate zoology; invertebrate zoology; embryology and basic knowledge of cells and tissues; ecology, natural history, and taxonomy; genetics, phylogeny, and evolution.

Applicants for admission to graduate study in zoology should have the equivalent of an undergraduate major in zoology, approximately twenty-five semester hours of course work. The equivalent of two semesters' work in physics, chemistry, and mathematics is highly desirable. Students admitted with deficiencies must make them up as quickly as possible. Knowledge of two foreign languages is necessary for advanced work in zoology, and applicants should have had some preparation in French, German, or Russian. A knowledge of Latin and Greek is also helpful.

The degree of Master of Science in Zoology is granted after completion of eight units of graduate work beyond the bachelor's degree and after the preparation of an acceptable master's thesis. Not more than three of the eight units may be acquired in thesis research courses. An oral examination is required at the end of the work for the master's degree.

Admission to advanced standing in the department for work leading to the

degree of Doctor of Philosophy requires a master's degree or its equivalent. Minimal science requirements for the degree include a basic training in zoology, at least one advanced course in physiology, and the equivalent of two courses each in physics, chemistry, and mathematics. Other courses or requirements may be recommended by the adviser and the student's doctoral committee. An oral preliminary examination is required of all graduate students. Prior to admission to the oral preliminary examination each applicant is required to satisfy the language requirements of the Graduate College, complete sixteen units of graduate work, spend a season at an approved marine biological laboratory and pass one formal course primarily concerned with marine invertebrate fauna, and pass the written proficiency examination in any three of the five areas of specialization within the department. The preparation of a satisfactory doctoral thesis and its defense at a final examination is required. It is also required that the results of the thesis investigation be presented at a departmental seminar. Further details relating to work in specialized areas in zoology and departmental requirements may be obtained by writing to the chairman of the department, 345 Natural History Building.

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology. Requirements for a minor in zoology are as follows:

Sole minor: four units in zoology, at least one of which must be in work open to graduate students only.

First minor: three units in zoology, at least one of which must be in work open to graduate students only.

Second minor: any two units in zoology offering graduate credit.

For the degree of Master of Science in the Biological Sciences or in the Teaching of the Biological Sciences and General Science, see page 65.

GRADUATE TEACHING FACULTY

Professors: J. B. Kitzmiller (Chairman of Department), F. B. Adamstone, B. V. Hall, D. Hoffmeister, L. Ingle, S. C. Kendeigh, W. M. Luce, D. L. Nanney, H. M. Smith, L. J. Thomas.

Associate Professors: J. O. Corliss, F. Kruidenier, M. R. Matteson, H. H. Shoemaker.

Assistant Professors: R. S. Bader, W. J. Birge.

Instructor: M. Greenberg.

COURSES FOR GRADUATES

403. Cytology. Structure and organization of the animal cell. I; 1 unit. Prerequisite: Consent of instructor. Adamstone.

404. Experimental Cytology. An experimental approach to knowledge of the chemical and physical structure of cells. II; 1 unit. Prerequisite: Consent of instructor. Birge.

407. Evolutionary Theory. Genetic, systematic, ecological, and zoogeographical concepts as related to the process of evolution. II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: One course in genetics or consent of instructor. Bader.

409. History of Zoology. The development of zoological concepts from the classical Greek period to the present. I; ½ to 1 unit.

411. Discussions in Genetics and Cytogenetics. Same as Botany 411. I, II; ¼ unit. Kitzmiller, Laughnan, Luce.

418. Advanced Protozoology. Advanced consideration of selected topics, with lectures, discussions, and readings; emphasis on laboratory practice in modern

methods and techniques of studying both free-living and parasitic protozoa: collecting, culturing, and staining of representative forms. II; 1 unit. Offered in 1960-1961 and in alternate years. Prerequisite: Zoology 318 or equivalent. CORLISS.

419. **Topics in Experimental Protozoology.** Consideration of the advantageous employment of protozoa in modern researches concerned with basic biological problems; selected experimental topics covered by lectures, demonstrations, discussions, reports, and readings. II; ½ to 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Consent of instructor. CORLISS.

420. **Experimental Invertebrate Zoology.** Study of current research problems and practice in the experimental methods used in the area of invertebrate zoology. I; 1 unit. Prerequisite: Zoology 320 or equivalent; consent of instructor. GREENBERG.

422. **Advanced Helminth Parasitology.** Advanced study of modern methods in helminthology. II; 1 unit. Prerequisite: Zoology 321 or equivalent. THOMAS.

424. **Invertebrate Taxonomy.** Individual problems in taxonomy of invertebrates. II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Zoology 304. MATTESON.

433. **Embryology.** A study of initial differences in developing systems and interactions leading to more complex differences. I; 1 unit. Prerequisite: Zoology 333.

435. **Animal Behavior.** Seminar on modern concepts, problems, and methods with special reference to vertebrates under free-living natural conditions. I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Zoology 335, 336, 337, or 338. KENDEIGH.

445. **Advanced Ecology and Wildlife Management.** Seminar on modern techniques, concepts, and problems. I; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Zoology 345 or equivalent. KENDEIGH.

446. **Physiological Ecology.** Physiological adjustments and responses of organisms to their environment. II; 1 unit. KENDEIGH.

455. **Advanced Genetics.** The gene in heredity, development, and evolution. I; 1 unit. LUCE, NANNEY.

456. **Physiological Genetics.** The nature of the gene and its action in the developmental and physiological processes of the organism. II; 1 unit. LUCE, NANNEY.

462. **Advanced General Physiology.** Same as Physiology 462. Seminar, lectures, student reports, discussions. I or II; ½ unit. Prerequisite: Consent of instructor. PROSSER.

467. **Experimental Embryology.** II; 1 unit. Prerequisite: Zoology 433 or equivalent.

499. **Thesis Research.** I, II; 0 to 4 units.

Work in the following fields is offered for students registered in Zoology 499:

Anatomy, Physiology, and General Classification of Vertebrates: Vertebrate Anatomy, BADER, SMITH; Histology, ADAMSTONE; Ultrastructure, HALL.

Anatomy, Physiology, and General Classification of Invertebrates: Helminthology, KRUIDENIER, THOMAS; Invertebrate Zoology, GREENBERG, INGLE, MATTESON; Parasitology, KRUIDENIER, THOMAS; Protozoology, CORLISS.

Embryology and Basic Knowledge of Cells and Tissues: Cytology, ADAMSTONE, BIRGE; Endocrinology, HALL; Embryology and Regeneration.

Principles of Ecology, Principles of Taxonomy, Natural History: Ecology, KENDEIGH; Herpetology, SMITH; Limnology, MATTESON; Mammalogy, HOFF-

MEISTER; Ornithology, KENDEIGH; Wildlife Management, KENDEIGH, SHOEMAKER; Ichthyology, SHOEMAKER.

Genetics, Phylogeny, Evolution: Genetics and Evolution, KITZMILLER, LUCE, NANNEY; Vertebrate Phylogeny and Paleontology, BADER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Seminar.** For members of the staff and graduate students. Required of all graduate students. I, II; no credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Parasitology-Protozoology Seminar.

302. **Individual Topics.** For those who wish to study individual problems. Graduates may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. I, II; ½ to 1 unit. Prerequisite: Two years of zoology; senior standing; approval of department. STAFF.

304. **Field and Systematic Zoology.** Collection, preservation, and identification of lower vertebrates and land and fresh water invertebrates; habits and life histories of selected forms. I; 1 unit. Prerequisite: One year of zoology or equivalent; senior standing or consent of instructor. MATTESON.

305. **Principles of Systematic Zoology.** Theory and practice in proper procedure for formation and for determination of status names for classification of animal populations. I; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Consent of instructor. SMITH.

306. **Biology for Teachers.** Same as Botany 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. Note: In order to make possible out-of-town practice teaching, this course does not meet during the six-week practice teaching period. II; ½ unit. Prerequisite: Botany 100 and Zoology 104 or 101, or a year course in general biology. MATTESON.

318. **Protozoology.** Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. I; 1 unit. Prerequisite: One year of zoology or equivalent. CORLISS.

320. **Invertebrate Zoology.** Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. II; 1 unit. Prerequisite: Zoology 101 or 104. GREENBERG.

321. **Helminth Parasitology.** Worm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz, demonstrations, and problems. I; 1 unit. Prerequisite: One year of zoology or equivalent. THOMAS.

324. **Vertebrate Paleontology.** Same as Geology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Zoology 132 or Geology 102. BADER.

330. **Practical Microtechnique.** An introduction to microscopy, microphotography, and histological technique. I; ½ unit. Prerequisite: One year of biology. BIRGE.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology; comparative anatomy, evolution and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous

systems. Lectures and laboratory. II; 1 unit. Offered in 1961-1962 and in alternate years. Prerequisite: Zoology 333.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. I, II; 1 unit. Prerequisite: Zoology 132. ADAMSTONE, KRUIDENIER.

334. **Vertebrate Histology and Cytology.** Microscopic study of the cell, tissues, organs, and organ systems of the vertebrate body. II; 1 unit. Prerequisite: One year of zoology or equivalent. ADAMSTONE.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. II; ½ unit. Prerequisite: Zoology 101 or 104. KENDEIGH.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. I; ½ unit. Offered in 1961-1962 and in alternate years. Prerequisite: Zoology 132. HOFFMEISTER.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. I; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Zoology 132. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. II; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Zoology 132. SMITH.

340. **Natural History of the Vertebrates.** Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. II; 1 unit. Prerequisite: One year of biology including Zoology 101 or 104. SHOEMAKER.

341. **Field Ecology.** Study of biotic communities, mammals, birds, reptiles, amphibia, fish, and invertebrates at Mammoth Cave National Park, Kentucky; Great Smoky Mountains National Park, Tennessee; and intermediate points, covering seven days over spring vacation. II; ¼ unit. Prerequisite: Credit or registration in one of the following: Zoology 304, 335, 340, 345, 446. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. I; ½ unit. Prerequisite: Zoology 101 or 104. SHOEMAKER.

343. **Limnology.** Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. II; ½ unit. Offered in 1960-1961 and in alternate years. Prerequisite: Zoology 101, 104, or Botany 100. MATTESON.

344. **Field Study of the Vertebrates.** Study of fish, amphibia, reptiles, birds, and mammals, with special emphasis on identification and life histories. Field trips. S; 1 unit. Prerequisite: One year of biology.

345. **Animal Ecology.** Dynamics, development, and distribution of biotic communities. I; ½ to 1 unit. Prerequisite: One year of zoology and/or entomology. KENDEIGH.

348. **Field Ecology.** Field studies of animal and plant communities in relation to their habitats. S; ½ to 1 unit. Prerequisite: One year of zoology. KENDEIGH.

349. **Animal Ecology.** Dynamics, development, and distribution of biotic communities. Credit is not given for both Zoology 345 and 349. S; ½ unit. Prerequisite: Registration in Zoology 348; senior standing or consent of instructor. KENDEIGH.

351. **Genetics.** Principles of heredity. Lectures, discussions, and laboratory experiments. II; 1 unit. Prerequisite: Zoology 101, 104, or one semester of any biological science. KITZMILLER, LUCE, NANNEY.

361. **Comparative Physiology.** Same as Physiology 361. A comparison of the general physiology of different groups of animals. I; 1 unit. Prerequisite: Three semesters of animal biology; two semesters of chemistry. ANDERSON, PROSSER.

362. **Cellular Physiology.** Same as Physiology 362. A physico-chemical analysis of biological functions common to most living cells. II; 1 unit. Prerequisite: Two semesters each of biology and general physics; three semesters of chemistry. ANDERSON, PROSSER.

363. **Endocrinology.** Same as Physiology 363. The glands of internal secretion with special reference to the vertebrates. I (annually); II (1961-1962 and in alternate years); 1 unit. Prerequisite: One semester of elementary zoology or physiology; Zoology 334 or organic chemistry. HALL.

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